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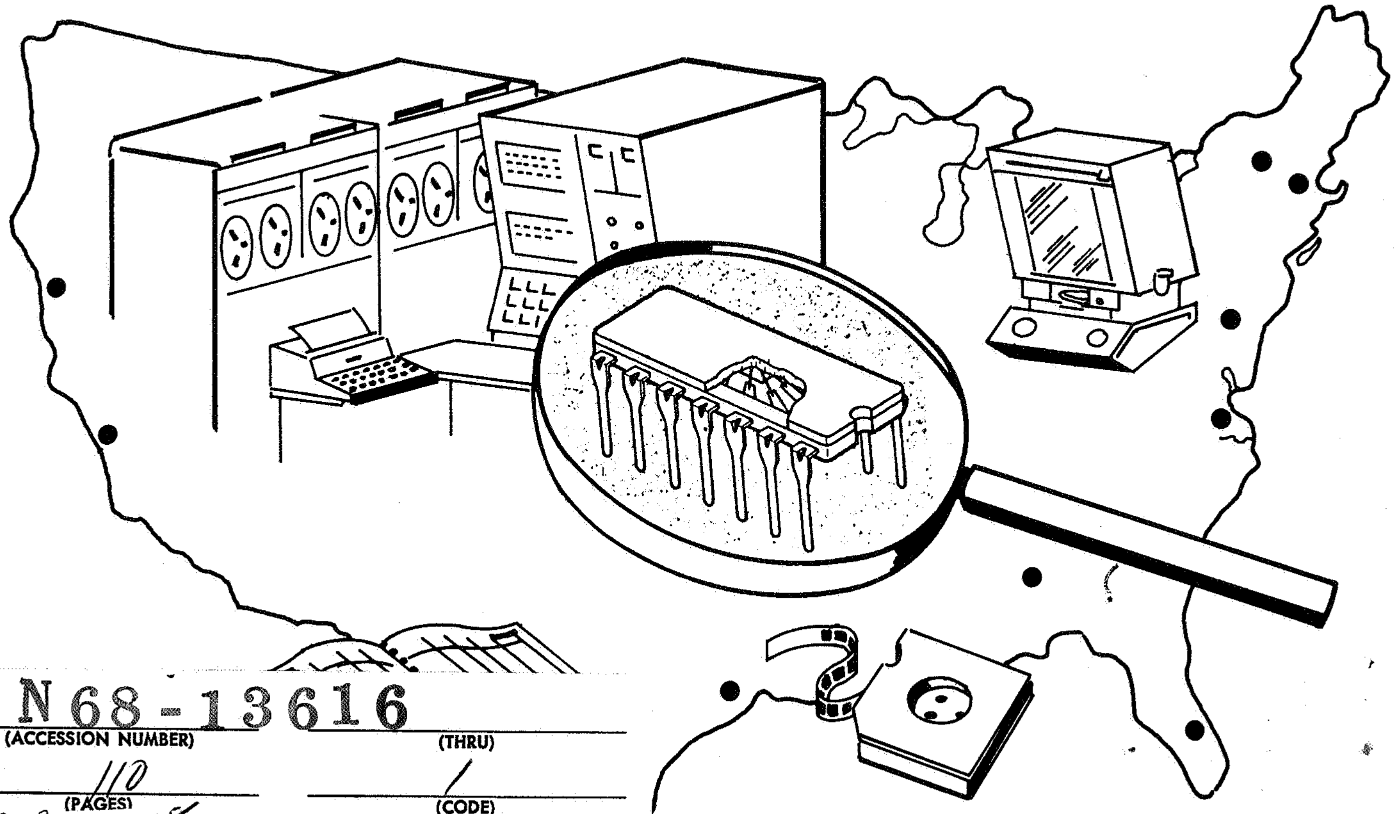
NASA
MICROELECTRONICS DATA BANK PILOT PROGRAM



VOLUME I: *MANAGEMENT SUMMARY AND TECHNICAL EVALUATION*

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Prepared under Contract No. NAS 12-147 by
INFORMATION DYNAMICS CORPORATION

Electronics Research Center
NATIONAL AERONAUTICS & SPACE ADMINISTRATION

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NASA MICROELECTRONICS DATA BANK

PILOT PROGRAM

VOLUME I: MANAGEMENT SUMMARY AND TECHNICAL EVALUATION

October 1967

Prepared under Contract No. 12-147 by

INFORMATION DYNAMICS CORPORATION

80 Main Street, Reading, Massachusetts

for

Electronics Research Center

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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PREFACE

This final report covers the development, implementation, and technical evaluation of the NASA Microelectronics Data Bank Pilot Program performed during the period from February 1967 through October 1967 on NASA Contract NAS 12-147. The total report has been divided into three volumes:

VOLUME I: MANAGEMENT SUMMARY AND TECHNICAL EVALUATION
VOLUME II: DESCRIPTION OF THE PILOT PROGRAM
VOLUME III: COMPUTER PROGRAMMING DOCUMENTATION

Original usage review forms and critique memos received from the field have been submitted to the Technical Monitor under separate cover and are not a formal part of this final report.

This Volume is divided into two parts. The "Management Summary" gives results of the overall system evaluation, conclusions and recommendations. It is predominantly qualitative; the quantitative analysis is covered in the analytical part of this Volume, the "Technical Evaluation."

The contractor is grateful for the enthusiastic support received from the NASA Microelectronics Subcommittee Members and their on-site Monitors at the Test Centers: Goddard Space Flight Center, Marshall Space Flight Center, Ames Research Center, Jet Propulsion Laboratory, Electronics Research Center, and the Rome Air Development Center of the U. S. Air Force. Without this support, successful fulfillment of the Pilot Program objectives would not have been realized.

ABSTRACT

This volume reports on results of the pilot test to evaluate the ability of the designed NASA Microelectronics Data Bank to respond to user queries, in an accurate and timely manner, under actual operating conditions.

The feasibility and acceptability of the Data Bank design and its operational services were verified during the pilot test. The critical need for a microelectronics data communications system was also verified, and it was demonstrated that the Data Bank has the ability to be responsive to this need. There was widespread agreement that the Data Bank's output products effectively performed their intended functions.

All of the goals and objectives of the Pilot Program were realized. This report recommends that an operational microelectronics data bank be implemented as soon as technically feasible and that specific steps be taken in order to arrive at a level of operational readiness.

CONTENTS

CONTENTS (Cont'd)

CONTENTS (Concl'd)

ILLUSTRATIONS

TABLES

MANAGEMENT SUMMARY

The primary objective of this Pilot Program was to test, measure, and refine the ability of the NASA Microelectronics Data Bank design to respond -- with accuracy and timeliness -- to user needs for information under actual operating conditions. The objective was achieved. This report on the Pilot Program is designed to provide NASA Management with an accurate and comprehensive measure of the system's effectiveness.

1. EVALUATION RESULTS

The Data Bank design was evaluated against carefully structured criteria directed toward the overall system performance as well as its three basic components -- the hard-copy Directory provided to each user, the microfilm file installed at each test center, and the computer query capability available via FTS (Federal Telephone System). Results of the Pilot Program evaluation, as stated in this Summary, are completely supported with detailed facts, statistics, and analyses in the remainder of the report.

The structured evaluation criteria are displayed as Figure 1, "Pilot Program Performance Measurements." An "X" indicates which of the system elements were measured against which performance characteristics; i. e., completeness (comprehensiveness); timeliness (currency); response time (turnaround time); specificity (detail); form (mechanics); format (layout); convenience (location); and efficiency (learning time and ease of use).

Performance Characteristics of Service	Overall Concepts	Output System Elements		
		Directory &Indexes	Microfilm File	Computer Query
Completeness	X	Limited	Limited	Limited
Specificity	X	Limited	Limited	Limited
Timeliness	X	No update	No update	X
Response Time	X	X	X	X
Form & Format	X	X	X	X
Convenience	X	X	X	X
Efficiency	X	X	X	X

Figure 1 Pilot Program Performance Measurements

The following summarization of the evaluation results are grouped in terms of the seven performance characteristics.

A. Completeness

The Pilot Program was planned with the overall intent of producing a demonstration that would be as representative as possible of a full-scale operational system. Since there was no intent for the Pilot to be complete in itself, measuring the completeness of its Directory, graphic file, and computer query capability serves no purpose. Only about 20 percent of the existing microcircuits were included in the Directory. The amount of usage history and reliability data in the graphic files was only a small percent of what a full-scale system would include.

Usefulness of the pilot version of the Data Bank was somewhat impaired by its lack of content completeness, but effective cooperation with ten vendors and the NASA Centers resulted in the acquisition of sufficient data representative of that available in a full-scale system. It was, therefore, possible to produce and critique the Pilot output products in terms of completeness of the concepts. Measuring completeness of the system concepts was a primary objective of the Pilot Program.

The overall Data Bank design and its operational services were thoroughly tested during the Pilot Program; its feasibility and acceptability were completely verified in actual user environments. Numerous suggestions were made relative to additional information and services desirable. Most of these were refinements or "advanced stage development" versions of the 21 basic service concepts already incorporated in the Data Bank design.

User reactions indicate that the Data Bank design concepts are complete and can be responsive to a much needed microelectronics data communications system.

B. Timeliness

It was decided that the Directory and microfilm file would not be updated with a second cycle of supplementary information during the Pilot Program. Therefore, timeliness for contents of these two output products could not be measured. The data accepted and included in the Directory and graphic files was, however, timely as of May - June 1967 when it was acquired. The original design concept calls for updating these two elements every two months. The consensus of the users was that this periodicity is adequate to maintain currency, if the computer can be queried between issues for assurance of timeliness when this is warranted.

It was made quite clear by many of the users that one of the key elements to the success of the entire system is the extent to which its data is timely. One of the remarks made most frequently was that many existing systems contain old data having little or no utility. The Data Bank will be extensively used, but only if it contains current information. This goal is attainable through a planned aggressive data acquisition function. Complete and timely data collection is vital.

C. Response Time

The amount of time between the users' initiation of the data search and receipt of a useful response is critical -- especially to engineers making design and reliability decisions. Minimal response time was a prime requirement in the design concept. The Directory, serving as the first level of access into the system, is "immediately" available on the user's desk. Here the response time is short; the Directory is organized in a manner that facilitates many of the routine searches. For these, retrieval is no more than a matter of minutes.

Full text back-up material is also obtainable in a matter of minutes for the user in proximity to the graphic file field installations. A sufficient number of microfilm reader/printers strategically placed will minimize the "walking" time. Through utility of the microfilm indexes, a precise cartridge identification scheme, and use of a motorized reader/printer, the desired textual information can be located expeditiously. Approximately 90 percent of the users expressed satisfaction with response time of both the Directory and the graphic files.

Response time of the computer query became an important issue to some of the users. Although 86 percent responded that they did receive an answer to their query in a satisfactory period of time, there was some divided opinion as to the need for on-line direct access to the computer. Direct access is expensive, and it is not at all clear that such a service is justified. Indeed, the current Data Bank design calls for oral communication with a microcircuit/computer analyst before the computer file is interrogated. This approach assures the greatest use of the computer store and associated manipulative capabilities.

During the pilot test, queries came directly from individuals or via the on-site monitors. The queries made by the program monitors were in the correct format and were based on a correct understanding of the services being offered. On the other hand, some queries received directly from individuals were more along the lines of "What do you have on circuit ABC?" They expected the computer to respond to vague queries rather than performing straightforward logical search and retrieval.

Technically, direct access could become a reality during an advanced stage of Data Bank development. One approach would be to provide the query analyst with a "multiprogramming support package" so that he could interrogate the computer (using a remote typewriter console) while talking to the caller. This would not only make the computer available whenever needed, but would permit the user to continue his dialogue with the analyst until the query was brought to a focus and answered satisfactorily. This is, in effect, quasi real time and should yield much more satsifactory results than widespread direct access.

It may be concluded that the response time for all of the output services is adequate. The response time for the computer query can be improved even further to achieve a conversational mode if the need warrants the additional expense.

D. Specificity and Accuracy

The level of specificity (i. e., the extent of detail) included in the output products was not completely amenable to measurement in context of the Pilot Program. However, the user comments indicate that there should be more detail rather than less.

An extremely important subject is accuracy; validity of the input data is a key ingredient. This point of view was clearly expressed by the users. It is imperative that every effort be made to assure that the information put into the Data Bank is valid. Dissemination of invalid data, no matter how little, will severely damage the reputation of the Data Bank. An effective data input evaluation and validation effort is an absolute necessity.

It may be concluded that the data included in the Pilot Program output products was below the level of specificity needed in a full-scale operational system. In the Pilot test it was not feasible to expend the effort needed to achieve this requirement at an operational level; it must be attained if the Data Bank is to be successful.

E. Format

There was nearly unanimous agreement that the mechanics of the system and the format of the output products were satisfactory. Several suggestions for improvement of the formats were offered but these all fall into the category of refinement and system "polishing." The overall formats were responsive to users' needs and displayed the information in a clear manner. A high percentage of the users stated or implied that they felt the need for the Data Bank and would definitely use it if it contains the information they desire.

F. Convenience

It was realized at the outset that this service characteristic would be another cornerstone to an effective design -- inconvenient systems are seldom used. The convenience of a desk-top Directory cannot be challenged. The computer query is no further from a user than his telephone. Regarding convenience of the computer query, a few users complained about the "wait time" involved in using the FTS network. The users could save time by directing straightforward queries to a local monitor (probably in the reliability and quality assurance group). He in turn could batch the queries and make periodic FTS calls to the remote computer facility. This procedure would make the computer search service more efficient and economical, and it would eliminate the requirement for users to be tied up on an FTS call for most of their queries.

Convenience of the microfilm files during the pilot test was below an acceptable level because only one file was installed in each center. At some decentralized centers three or four reader/printers would be a minimum to provide the level of convenience needed to enhance the usefulness of these graphic files.

G. Efficiency

User reaction indicated overall success of the system in providing an effective microcircuit information communication system. Use of all of the output products requires a learning time, but the Pilot Program revealed that the engineers experienced very little trouble in learning to use these products.

The method of using the Directory can be learned in about ten minutes -- directions for its use are included (on one page) in the front of the document. The use of microfilm reader/printers was already familiar to most engineers through other information systems employing this method. Reader/printer operation was described and demonstrated in about five minutes. Most engineers are also quite familiar with computer interrogation schemes and found no problem in accepting and using this service.

2. CONCLUSIONS

As a result of the technical evaluation performed in this report, it is concluded that:

A. FEASIBILITY AND ACCEPTABILITY OF THE DATA BANK DESIGN WERE VERIFIED IN ACTUAL USER ENVIRONMENTS.

The Data Bank design was thoroughly tested during the Pilot Program. The maximum number of Data Bank services demonstrable during the Pilot Program, and necessary to prove the feasibility of the system, were demonstrated in the field. The system was successfully tested for six weeks at six selected test centers. During this period the Directory, microfilm files, and computer query capability were all utilized sufficiently for the compilation of user reaction statistics necessary to perform a sound engineering evaluation of the output products and overall system design.

It can be stated with a high degree of confidence that the test centers and participants represent an excellent cross section of the user community. A total of 103 NASA and NASA contractor engineers actively participated in the Pilot Test Evaluation; personal interviews were conducted with 85 users; 76 users completed, signed and submitted directory usage review forms; 38 computer queries were made. The statistical analysis performed in this report concludes that the views expressed by the respondents are an accurate reflection of the responses that would be expressed by the total population of potential users.

On the basis of user reactions, there is widespread agreement that: (a) there is a definite, even serious, need for an information system like the Microelectronics Data Bank, and the need is growing; (b) the system is well designed and, if the data can be procured, it would be a widely used system. Acceptance of the system design has been fully verified; NASA engineers want, need, and <u>would use</u> the system.

B. THE DIRECTORY EFFECTIVELY SATISFIES THE NEED FOR A DESK TOP BOOKFORM MICROCIRCUIT DIRECTORY, BUT SHOULD BE EXPANDED.

Ninety percent of all Center users expressed satisfaction with the Directory.

Numerous comments were made relative to the need for additional information in the Directory, including: cost or cost ranges of devices; additional digital and linear circuit characteristics; device package outlines; expansion to include more than integrated circuits (discrete parts); more information on environmental test data; breakdown by family types; circuit classification scheme; and expansion beyond monolithic circuits. These results are indicative of the desire and need for a microcircuit information system. In spite of the overwhelming acceptance of the Directory, additional efforts should be expended on putting as much information into the Directory as is economically and technically feasible.

C. THE CARTRIDGE MICROFILM SYSTEM EFFECTIVELY DISSEMINATED FULL TEXT DATA.

The original design choice among microfilm systems has been proven correct: cartridge microfilm meets all of the system requirements and is the best means for disseminating decentralized full-text data files. The method had previously been in use so the practicality of cartridge film systems had already been demonstrated. Their use during the Pilot Program did not present any problems.

D. THE FEASIBILITY AND UTILITY OF THE REMOTE COMPUTER QUERY SERVICE WERE DEMONSTRATED AND POSITIVELY VERIFIED.

Access to a remote computer logical query capability during the Pilot Program was developed and implemented; the computer was also programmed to produce the pilot Directory. The computer query capability responded swiftly to nearly all requests in spite of some inherent problems with the FTS network. Most users were completely satisfied with the specificity, format, and timeliness of the computer services. Over three-fourths of the users found the Pilot's limited computer service useful. There is great potential value of this service far beyond that provided in the Pilot Program.

E. SUCCESS OF THE SYSTEM DEPENDS UPON ADEQUACY OF FTS DATA CONTENT; THIS CAN BE ASSURED THROUGH EFFECTIVE NASA-WIDE MICROCIRCUIT DATA EXCHANGE.

The greatest need expressed was for reliability and usage history data not generally available elsewhere. Success of the system is almost guaranteed if this data is comprehensive, timely and accurate; such a goal is attainable through aggressive data acquisition and thorough data input evaluation and validation. It is imperative that all input data be validated. Publication of erroneous data will severely damage the effectiveness of the Data Bank.

The success of the system also depends upon the cooperation and exchange of microcircuit information among the NASA Centers; the greater the participation, the more successful the Data Bank will be. A separate Data Bank on microelectronics is justified; the Microelectronics Data Bank would provide a valuable complement to existing systems. A cooperative interchange of information between these systems would increase the coverage, decrease duplication, and enhance the usefulness of all systems.

3. RECOMMENDATIONS

It is recommended that a fully operational Microelectronics Data Bank be funded and implemented as soon as technically feasible. In order to arrive at this level of readiness, the following recommendations should be carried out:

* Expand the technical data base developed during the Pilot Program to maximize its scope, currency and, therefore, its utility to NASA.

* Emphasize expansion of the technical data base on obtaining the most current reliability and usage history data. Technical data of the following types should be procured from NASA Centers and contractors: applications data, control drawings, purchase specifications, qualification test reports and procedures, screen test reports and procedures, NASA and DOD specifications and standards, field failure reports, failure analysis reports, corrective action reports and general reliability reports.

* Develop methods for screening, evaluating and validating the technical data acquired. This process must be developed before a full-scale system can be implemented.

* Establish expeditious information input pipelines through cultivation of data collection contacts at NASA Centers, contractors and DOD. Fostering such cooperation and initiating exchange of information and active participation will contribute significantly toward the ultimate success of the Data Bank.

I. INTRODUCTION AND REVIEW

A. Background

This report describes the systems engineering and technical development work completed under NASA Contract NAS 12-147 by Information Dynamics Corporation for the design, implementation, and evaluation of a Microelectronics Data Bank Pilot Program. This effort represents a continuation of the previous study which covered the preliminary design and development of a Microelectronics Data Bank. Figure 2, "Overall Program Schedule," shows the chronological relationship of these two programs.

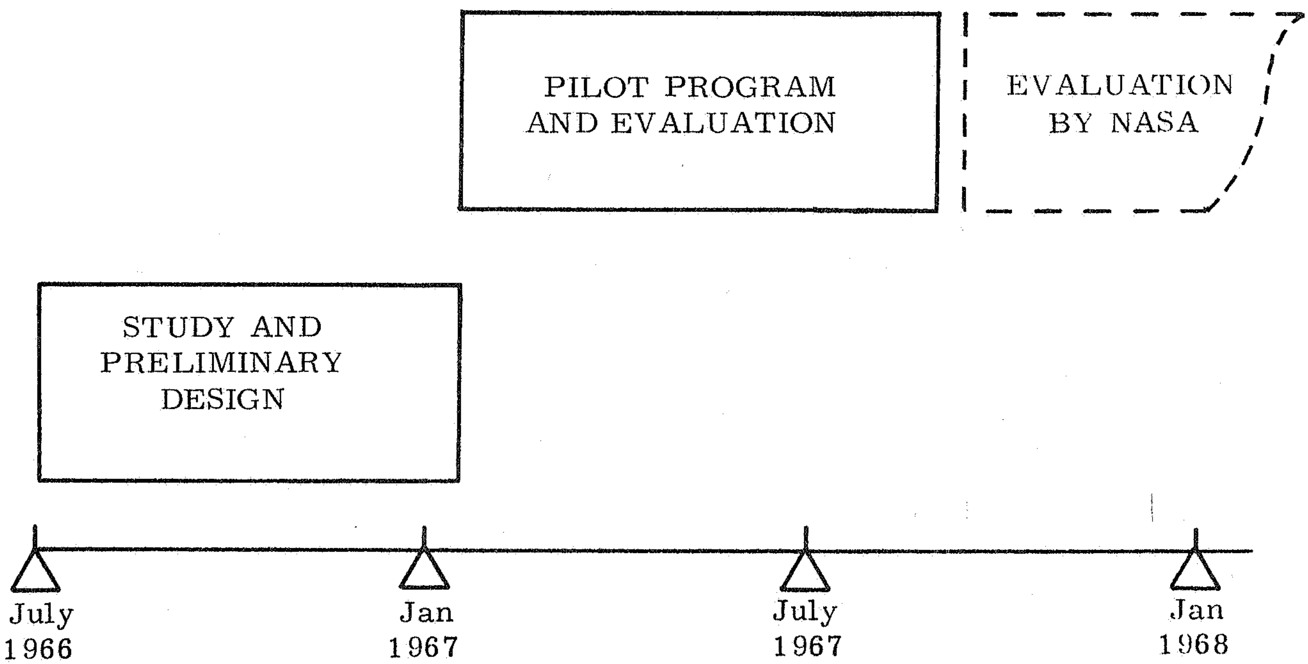

Figure 2 Overall Program Schedule

The Microelectronics Data Bank Program described in this report would be an essential element in the broader Microelectronics Reliability Program now being developed by the Microelectronic Subcommittee of the NASA Parts Steering Committee. Under this program, new procedures are being developed to achieve better qualification, specification, process control and testing of microelectronics.

Electronics is an essential element in every aspect of space flight; microelectronic technology promises to provide electronic circuits having a much higher inherent reliability than that available, to date, through the assembly of discrete components. The trend of commitment of space systems to microelectronics was examined by the Office of Reliability and Quality Assurance, NASA Headquarters, in December 1965. It was determined that by 1970 approximately 70 percent of the spacecraft systems would be utilizing microelectronics. This represents a doubling of the use of microelectronics between 1967 and 1970.

Microelectronic technology, however, presents many new problems in reliability. The Microelectronic Subcommittee of the NASA Parts Steering Committee was established approximately two years ago in recognition of these problems. An important element in its reliability program is the communication system that (1) gathers data and (2) provides information services to personnel requiring access to technical data needed in decisions concerned with reliability as well as circuit design. The data collection, storage, dissemination and communication features of the Data Bank would well serve the needs of this program.

B. Role of the Data Bank

The Data Bank would play a vital role in the collection, organization, analysis and dissemination of vital microelectronic data and information to NASA engineers, their contractors and subcontractors. The role of the Data Bank may be summed up as follows:

1. It would serve as the primary communication means for centralized collection and dissemination of the in-depth application data on an initiative basis to microelectronics users. The technology of microelectronic devices is complex. The detailed data necessary to achieve a reliable application goes far beyond the handout catalog data and introductory information distributed through marketing channels. NASA microelectronic users require supporting in-depth technical application data describing the full range of performance characteristics under wide limits of environmental conditions. Without this data, a spaceborne application of the microelectronic device cannot be safely designed.

2. It would provide a current awareness to authorized procurement personnel of the approval status of vendors, their production line certifications and their circuit qualifications. If these procedures, which are being developed under the Microelectronics Reliability Program, are implemented and maintained they will supply current in-depth information on all manufacturers supplying microcircuits to NASA.

3. It would provide, on a NASA-wide basis, an access to experience history both in the areas of application and reliability results. Both favorable

and unfavorable experiences with vendors, with circuits having undergone testing, and with circuits in use represent vital information to a prospective microelectronic user.

4. It would provide the central point for collection and analysis of raw and reduced test data necessary for the calculation of a meaningful reliability figure for a given device. Test result summaries from qualification and screen tests are necessary for a user to evaluate the suitability of a device for his requirements. The Data Bank will provide a central access point of references to previous qualification test results and present the standards and test specifications used in conducting these tests. The Data Bank will also provide a central access point for field failure analysis reports. Such reports are diagnostic in content and contain information of widespread interest to all users of microelectronics concerned with reliability.

5. It would provide a mechanized capability for performing computer searches and logical correlations among circuit and performance characteristics, test results, reliability trends and other information services amenable to computer manipulation and analysis.

In summary, the Microelectronics Data Bank provides NASA and its contractors with an effective communication system necessary to carry out the objectives of its Microelectronics Reliability Program.

C. Highlights of Data Bank Design

The NASA Microelectronics Data Bank is a repository, and an effective communications system, for providing a complete integrated set of information services and products to scientific and technical personnel throughout NASA and NASA contractor organizations. The Data Bank is directed to persons making the decisions that affect the reliability of microelectronic devices purchased and employed in NASA programs.

Highlights of the Data Bank design include:

* Only the field of microelectronics would be covered, but the coverage would be in great depth

* Would be responsive to a wide range of user interests serving a divergent user community

* Technology oriented rather than mission or project oriented

* Would permit extremely short data access time

* Designed with maximum flexibility to keep pace with the rapidly changing technology and associated changing information requirements

* Would maintain a continuous, fast reacting, communication link with microcircuit suppliers and users

* User is "guided" through the system and led directly to the information he is searching for, <u>or</u> his search is halted almost at once if the system does not contain the data he wants

* Provision of direct information and services "on the spot" rather than referring the user to a second source

* Dissemination of timely and accurate data through continuous aggressive data acquisition efforts and data input evaluation and validation.

A complete description of the role and design of the Data Bank appears in the publications documenting the work performed in the preceding contracts; see IDC (Ref. 5), IDC (Ref. 6) and IDC (Ref. 7) in the Bibliography of this report.

For the sake of completeness, a summarization of the Data Bank design is included in Volume II of this report. Some of the design description appearing in Volume II did not appear in previous publications but was developed during the course of the Pilot Program as a result of further analysis and refinement of the preliminary design.

II. DESIGN OF THE PILOT PROGRAM

Before the usage review responses may be technically evaluated, it is first necessary to clearly establish the framework around which the Pilot Program was designed by stating its overall objectives. Furthermore, in order to validate the results of the program, the design methodology and its effectiveness must be described. Finally, before the validity of the results can be confirmed, it is of paramount importance to show that the method of selection and the magnitude of the sample is sufficient to establish concrete statistical significance.

A. Objectives of the Pilot Program

Volume II of this report describes the operational aspects of the Pilot Program; it covers aspects such as what was done and how it was done. These considerations will be only briefly mentioned in Volume I. This volume determines how well the Pilot Program was performed. Its primary purpose, however, is to report the results of the system test and to technically evaluate its performance against user requirements under actual field operating conditions.

It was concluded, in the preceding design study, that it would not be wise to proceed into a full-scale operational information system without a measure of the effectiveness of the proposed service concepts and the output products of the system. It was necessary to determine if the proposed service concepts were adequate and, if not, to refine and adjust the design choices. It was also possible that additional service concepts would be identified during the Pilot Program.

The Pilot Program was conducted to: verify the need for a microelectronics communication system; determine if the Data Bank would be responsive to this need; and determine if it is an effective design assuring high probability of use by NASA engineers.

It was also an objective of the Pilot Program to simultaneously provide solutions to several start-up problems in preparing the collected information for processing. A further objective was to establish working relationships with microelectronic device manufacturers, thereby initiating data collection "pipelines" needed for an operational system. This objective also covered the initiation of working relationships with a representative group of NASA Centers to evaluate their acceptance of responsibility in providing information required to define the procurement, usage and reliability history of microelectronic devices.

The overall objective of demonstrating the major service concepts and output products is best summarized by Figure 3, "Pilot Program Input/Output Diagram." This figure depicts the inputs to and outputs from the Pilot Program.

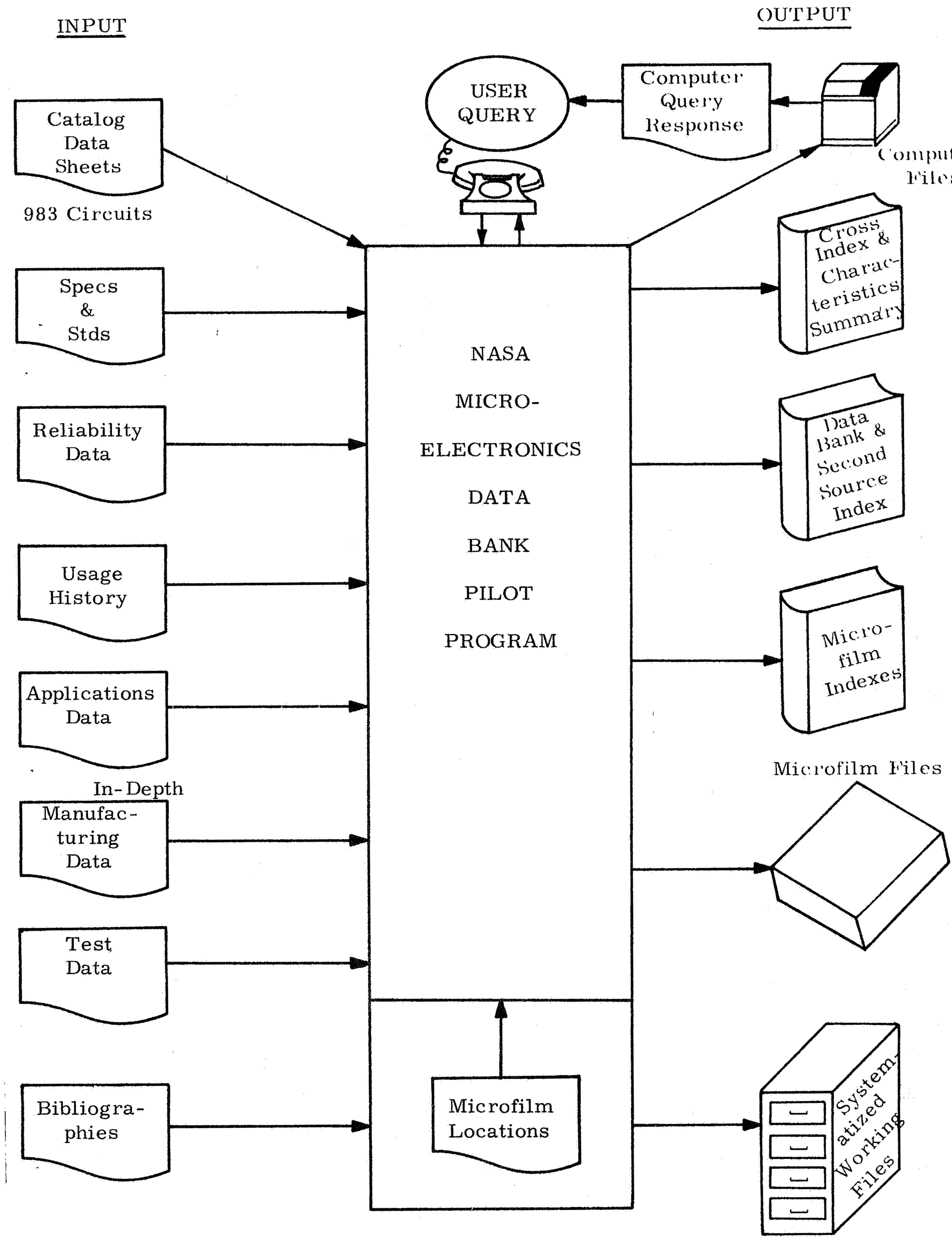

Figure 3 Pilot Program Input/Output Diagram

B. Design Approach

The design approach, leading to the system evaluation, was performed in six progressive steps: selection of representative services; collection of representative data; assembly of representative products; demonstration of the system; operation in user environment at controlled points; and evaluation of performance. These six functional steps will be discussed individually.

1. Selection of representative services. --It was not possible, or even necessary, to demonstrate all of the original 21 service concepts within the resource limitations of the Pilot Program. Therefore, at the outset, IDC and the Technical Monitor agreed upon which representative service concepts would be demonstrated during the Pilot Program. Figure 4, "Selected Pilot Program Service Concepts," lists the 21 service concepts in abbreviated form and indicates which were demonstrated during the pilot test. Figure 3 also indicates the data source (Directory, microfilm files, or computer files) from which the users would derive this information.

It should be noted that Service Concepts 2, 3, and 4 as well as Service Concepts 12, 13, and 14 were deleted from the pilot test, since these six concepts deal with the currently unavailable Supplier Approved Lists (SAL), Certified Lines Lists (CLL), and the Qualified Circuits Lists (QCL). However, the Data Bank has been designed to incorporate this information as soon as it becomes available. Service Concepts 15, 17, 19 and 20 were also deleted as they are not applicable to the concept of a pilot test program. Service Concept 21, a second source index depicting circuits that are electrically and mechanically interchangeable, is a new service identified during the Pilot Program design phase.

During the early phases of the pilot design, the importance of the computer in Service Concept 1 was identified. It was decided that provision of some computer manipulation of circuit characteristics data would be desired by users during the pilot test. The scope of this service would be increased many times in a fully-operational system.

It was also found during the pilot study that the computer could logically perform many data analyses currently performed manually in a duplicative fashion by many NASA engineers. However, it was recognized that a true test of the complete computer capabilities would not be possible in the pilot due to insufficient resources to write the kinds of data manipulation programs necessary to demonstrate its full service potential.

2. Collection of representative data. --Several important decisions were made at the early stages of the data acquisition task. Of the 30 or so microcircuit manufacturers, ten manufacturers were selected, contacted and asked

◯ = In Pilot

Service No.	Description	Users Data Source: Directory	Microfilm	Computer
1	Performance data in terms of characteristics	X	X	X
2	Supplier approved list (SAL)	X		
3	Certified lines list (CLL)	X		
4	Qualified circuits list (QCL)	X		
5	Access to who is using specific devices	X	X	X
6	Access to valid reports on reliability test results, failure analysis reports and field failures		X	
7	Information to show basis of screening procedures		X	
8	Qualification specs, test procedures, test results, etc.		X	
9	Access to general specs cited on control drawings		X	
10	Access to detailed specs used by others		X	
11	Access to "first level" or referenced supporting specs and stds		X	
12	Access to full text reports of surveys made for SAL		X	
13	Access to full text reports of surveys made for CLL		X	
14	Access to full text reports of surveys made for QCL		X	
15	Flash notification *			
16	Mechanized capability for Data Bank search			X
17	Reference services *			
18	Bibliography (listing) of reports on microelectronic technology	X		
19	Maintain microelectronic related computer program library service *			
20	Assist in identification of areas requiring further research *			
21	Second source index	X		

*Provided directly from Data Bank operations.

Figure 4 Selected Pilot Program Service Concepts to participate in the Pilot Program. These manufacturers were: Fairchild, Motorola, Philco, Raytheon, RCA, Signetics, Sylvania, Texas Instruments, Transitron and Westinghouse. A carefully constructed letter (see Volume II) was sent to these manufacturers asking for catalog data, applications data, in-depth data and specifications and standards. Details and examples were given to each vendor so they would know precisely what they were being asked to provide.

In addition, each of the NASA Centers was contacted by letter (see Volume II) and asked to submit readily-available information covering the following 11 data categories: applications data, screen test procedures, vendor survey reports, screen test reports, control drawings, failure analysis reports, corrective action reports, purchase specifications, specifications and standards, qualification reports and field failure reports. Each category was also defined in detail with examples so that the NASA Centers could readily identify the type of information requested of them.

The data collection approach was to collect as much readily-available information as possible on approximately 20 percent of the existing circuits, instead of collecting a great depth of information on a small number of circuits. This latter approach would have made it impossible to prepare a directory realistically portraying the functional utility of such a document in a full-scale system.

For the reasons shown in Figure 5, "Data Selection," it was decided early in the planning phases not to include raw test data in the Pilot Program. Basic to this decision were: lack of standardization throughout industry regarding the overall collection of raw test data; the lack of process controls in the actual collection of such data; the great variability in the equipment and procedure in generation of such data; and the serious problem of allowing the Data Bank to provide information that can be easily misunderstood and/or misused because of the vague method of its collection.

It was, however, recognized that a definite need exists for raw test data. Such information is extremely useful for evaluation of new circuits, for portraying the distribution of curves between worst case limits and for showing erratic behavior at high and low temperatures. But the general problem of <u>what</u> to provide in the area of raw test data and <u>how</u> to provide it was beyond the scope of the pilot study.

On the other hand, it was decided that reduced or summarized test data would be included in the Pilot Program (assuming successful procurement of such information). This type of information plus usage history data, reliability data, specifications and standards and bibliographic information (pertinent to specific microcircuits) were collected and made a part of the microfilm files.

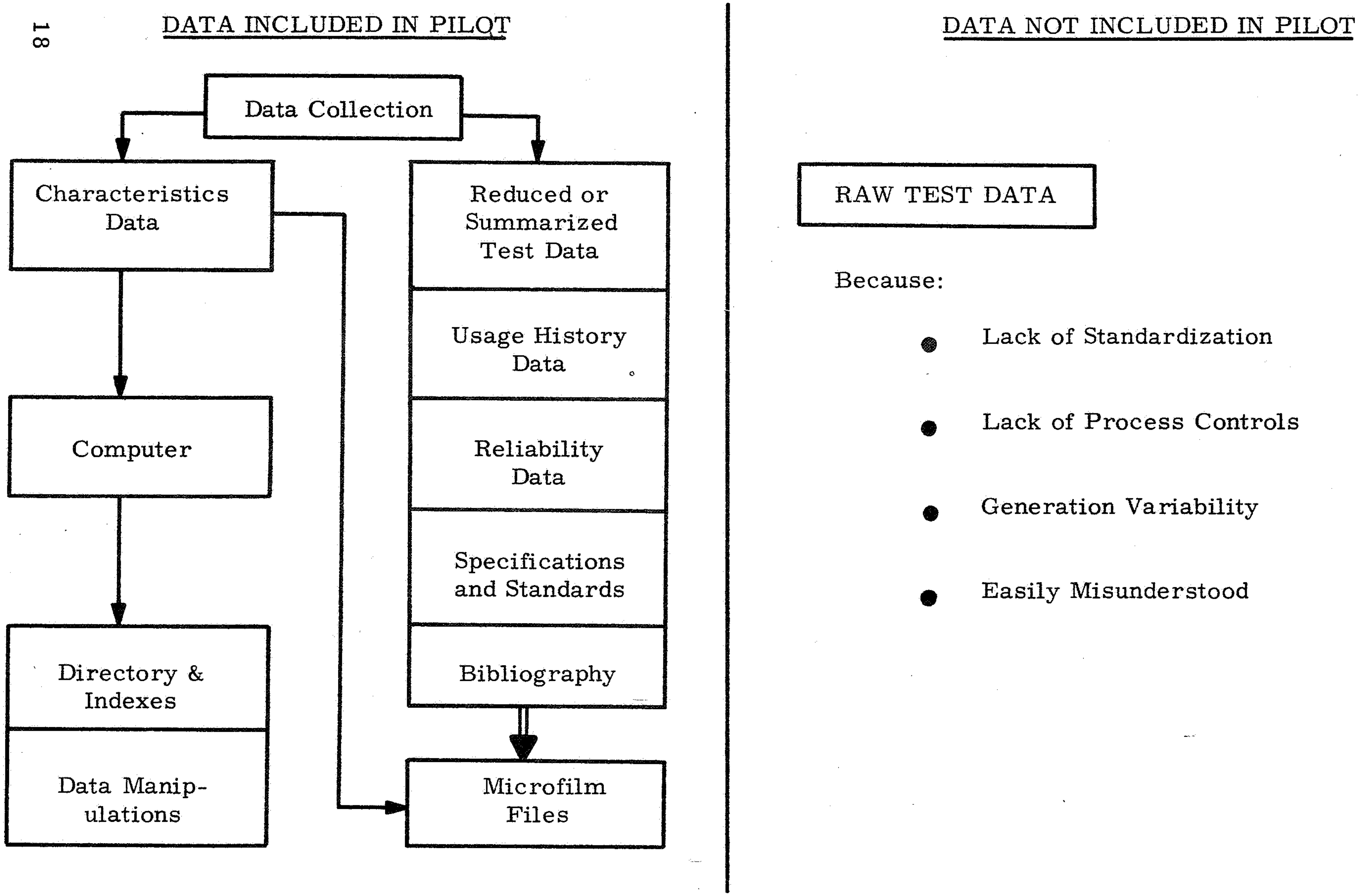

Figure 5 Data Selection

3. Assembly of representative output products--book form, microfilm and computer files. --In order to promote an effective pilot test it was necessary to prepare a representation of each major output product. The Data Bank Directory (or book-form file) was produced and included the Type Number Cross Index, Characteristics Summary Data, Data Bank Index, Second Source Index, and the Microfilm Indexes. Although only 20 to 25 percent of the currently existing microcircuits were included within the scope of the Pilot Program, every effort was aimed at making the Data Bank Directory representative of the type to be produced in a full-scale system.

It was determined that cross referencing and interfacing among portions of the Directory were of sufficient complexity to warrant computer production. Furthermore, computer generation is amenable to format reorganization with minimal effort. Preparation of a representative Data Bank Directory during the Pilot Program also facilitated the additional polishing needed prior to its production in a full-scale system. It further provided the media through which several of the service concepts were realistically demonstrated. The pilot version of the Directory is exhibited in Volume II.

All of the acquired data that passed through the selection screen was microfilmed after being organized into five categories: technical data, usage history, specifications and standards, reliability data, and bibliographies. This is exactly the organization that would be used in a full-scale system except for the exclusion of SAL, CLL and QCL lists and full-scale reports not available during the Pilot Program. Twelve microfilm cartridges were produced.

Although the volume of data included represented only a small fraction of the total volume that would be contained in a full-scale system, it nevertheless demonstrated the types of information available on microfilm. It further demonstrated the method of organizing this data for presentation, and it provided the means for assessing user reaction to the utility of a micrographic file.

All of the circuit characteristics displayed in the Directory were placed in machine-readable form. This not only made it possible to provide a computer-generated Directory, but also provided an active computer query capability. Although a logical search of microcircuit characteristics is but a small fraction of the total capability of the computer in assisting the user community, it was nevertheless an effective method of testing the operational characteristics of an off-site, computer-based search service and computational facility. It also provided the means of testing the acceptability and effectiveness of the telephone (utilizing FTS) as a means of communication with an off-site computer/microcircuit analyst, who served as the interface between the query originator and the computer.

4. Demonstration of the system. --It was necessary to demonstrate the system before the NASA Microelectronics Subcommittee members and the test site monitors prior to field testing. In order to assure a successful program, it was absolutely essential that the monitors had a complete understanding of Data Bank mechanics, plan of the pilot test, when and where each element of the plan would be performed, and who would be responsible for what tasks before, during, and after the field test. All of these aspects were covered in a two-day meeting in Boston in late June just prior to field deployment of the system.

A laboratory type demonstration was used to simulate a realistic user environment. A typical user sat at a desk with a copy of the Directory, a telephone and a microfilm reader/printer immediately available. Several actual searches were made showing how the Directory provided immediate access, how the microfilm reader/printer displayed more detailed information, and how the off-site computer facility could be queried by telephone.

The method of locating specific data in the microfilm cartridges, using the microfilm indices and code-amatic indexing marks on the microfilm, was demonstrated. The ease of obtaining hard copy print from the microfilm reader/printer was also demonstrated. Figure 6 shows data being located on a microfilm reader/printer with the Directory and microfilm cartridges alongside.

Off-site computer queries (IBM 360 computer facility in an adjacent building) were also demonstrated as well as the method utilized by the computer/microcircuit analyst in actually performing a query of the computer via the (typewriter) console. This entire demonstration was very effective in giving the monitors a clear view of what was planned and what was expected of them. Without this clear understanding, the success of the remaining aspects of the Pilot Program would have been impaired.

5. Operation in user environment at controlled points. --Six Centers were selected for demonstration of the system to provide a representative geographic and organizational spread. The Centers selected for the demonstration spanned the nation. Just prior to actual system installation at each of these pilot points, orientation briefings were conducted for all of the potential users of the system. These sessions included demonstrations somewhat similar to the monitors' demonstration discussed above.

The Directories and one complete set of microfilm cartridges were disseminated to each pilot point and placed under cognizance of the on-site monitor. The off-site computer, which was made available to all users for a six-week period, was reserved entirely for Data Bank query for one hour each day, at which time a 10 - 20 minute response time could be expected.

Figure 6 Location of Data on Microfilm Reader/Printer

6. Evaluation of performance.--A set of criteria was developed for measuring the characteristics of the systems output elements. These characteristics are given in Figure 1 and are discussed above in the Management Summary.

In order to collect information from users for statistical analysis of the system performance measurements, three "usage review forms" were designed, one each for the Directory, the graphic files, and the computer query. The Directory Usage Review Form was physically included in each Directory with instructions to the user to fill it out and return it to his monitor after using the Directory in an actual search. For the graphic files, a log book accompanied the microfilm cartridges to each of the six pilot locations. The log book contained a review sheet on which each user was asked to indicate the successfulness and method of conducting his search. Effectiveness of the computer query during the Pilot Program was determined by a five question quick check-off sheet. This form was mailed to the user with the computer response from his query and he, in turn, returned the filled out assessment sheet to his local monitor.

The usage review forms returned by the users represent the real foundation upon which the technical evaluation is based. They contain very explicit points of view. They were signed or initialed by the users and returned to the local monitors. They represent physical, documentary evidence of user reaction to the Data Bank under actual operating conditions.

According to those who have studied the collection of data by sampling, for example see Hanson (Ref. 4), the questionnaire method is the least expensive way to collect data. However, a return of 20 to 30 percent is considered high. It was determined in advance that a minimum of 50 Directory usage review sheets was needed to conduct the statistical evaluation with a reasonable high level of confidence. Understanding the reluctance of engineers to fill out questionnaires, follow-up letters were sent and/or phone calls made to all recipients of the Directory at each Center.

An important element of the system evaluation was the personal interviews conducted at all of the test Centers. Even though acceptance of the system was to be validated primarily from an evaluation of the usage review forms, it was important to talk to as many users as possible. Such conversations reveal needs for specific information services and give a true insight into the users' acceptance of the system -- leading ultimately to its success or failure.

Anticipating the possibility of inadequate response, and the need for a contingency plan, the contractor representative noted in detail the viewpoints of each person interviewed. This plan called for the interviewer completing a Directory usage review form for each user who had not submitted one voluntarily, then mailing it to him (with his name typed on it), asking for his approval, signature and return. The contractor had utilized this method in the past with significant success and was prepared to employ it if voluntary response was inadequate to provide the level of statistical significance desired.

C. Effectiveness of the Design Approach

The above discussion delineates the technical plan for conducting the Pilot Program in such a manner that it could be effectively evaluated. It is now possible to evaluate the effectiveness of the selected approach.

1. <u>Effectiveness of data acquisition.</u> --The cooperation of all of the NASA Centers and manufacturers contacted for source data was extremely gratifying. The microcircuit vendors displayed a willingness to cooperate with the objectives of the Data Bank. Sample correspondence from the vendors is included in Volume II.

Although a great deal of representative types of data was collected during the short time allotted for data acquisition, it was somewhat meager compared to the volume of data that actually exists. This unavoidable circumstance to some degree restricted the overall effectiveness of the Pilot Program in that many engineers who wanted to utilize the system did not because of the inadequacy of the data included. Engineers generally prefer to operate within a framework of reality, and many were not motivated to utilize the system unless they felt it could directly serve their immediate needs. These factors, although true, did not seriously harm the effectiveness of the Pilot Test Program; enough engineers did actively participate (103 to be exact) to provide the kind of information needed to evalute the system.

2. <u>Effectiveness of usage responses.</u> --The book form (Directory) file, the microfilm file, and the computer file were all assembled on schedule in preparation for the system demonstration. The Directory was distributed to the 280 persons who attended the orientation sessions. All three system elements were utilized during the pilot test to obtain a sufficient volume of user reaction statistics.

At the conclusion of the assessment interviews, a total of 40 Directory usage review forms had been received. This was below the 50 returns considered minimal for a high level of confidence. As a result, the contractor decided to initiate the contingency plan described above. Fifty-three Directory usage review forms were prepared on the basis of the personal interviews and mailed to each individual involved. A total of 36 of these forms (68 percent) was returned.

When all responses were received, a grand total of 76 Directory usage review forms were available for detailed analysis. Table I shows the distribution of these responses by test Center as well as the percentage return from those briefed and those interviewed. All Centers registered a respectable percentage return (a 20 to 30 percent response from a questionnaire is considered very high).

TABLE I
DISTRIBUTION OF DIRECTORY
USAGE REVIEW RESPONSES BY CENTER

Test Center	Number of Responses	Percentage Returned	
		From Those Briefed	From Those Interviewed
GSFC	12	18	50
MSFC	14	19	50
Ames	11	30	64
JPL	20	32	91
RADC	9	41	80
ERC	10	59	100
TOTAL:	76		

There is no special significance to the percentage of forms returned by individual Centers until it is compared with the percentage of returns received from those interviewed. Doing so, we see at least twice the percentage of those interviewed submitted usage review forms compared to those who were briefed and not interviewed. This clearly displays the effect of a personal interview on the compilation of field data. Of the 85 persons who were interviewed, 59 (70 percent) submitted a Directory usage review form.

The 76 usage review responses, the 85 personal interviews, the five critique memos submitted and the 38 computer queries conducted during the pilot test made it possible to evaluate the effectiveness of all three system elements. Since it was not possible to maintain full-time surveillance of the microfilm files, the exact number of persons who benefited from their full-text copy retrieval capability was not documented. This in no way impaired the ability to assess the functional utility of microfilm files since 18 percent of those interviewed made specific comments thereby providing enough data to analyze the acceptance and usefulness of the micrographic file.

3. Overall effectiveness.--It is now possible to draw some conclusions as to the effectiveness of the Pilot Program approach. A grand total of 103 persons actively participated in the evaluation, far more than the 50 responses hoped for at the outset in order to attain a high level of statistical significance. Cooperation of the 103 users has made possible a sound engineering evaluation of the output products and overall system design. Specific technical evaluations of the usage review responses and personal interviews appear in the remainder of this report.

D. Selection of the Sample

The reliability of sampling is a well-established statistical reality. However, the sample must be properly selected and the sample size must be of adequate magnitude to provide a high degree of confidence that the results will reveal an accurate picture of the population being investigated. Both of these aspects must be examined before the technical evaluation may proceed.

1. Sampling method.--Of the five or six widely used methods of sampling only two, the "random" and the "stratified," are pertinent to the pilot evaluation study. The random method allows each item in the universe being sampled to have an equal opportunity of being selected. The stratified approach refers to the capability of selecting homogeneous groups (or strata) from within a larger heterogeneous group. The "random-stratified" sampling method was employed in selecting the sample for participation in the pilot test evaluation. It is superior to a simple random sample because it is likely to be more representative of the population which is being sampled. Furthermore, stratified samples can attain a higher degree of accuracy with a given sample size than do simple random samples.

2. Selection of participants.--Although the total number of potential Data Bank users is unknown, from a statistical standpoint, the population is frequently unknown and mathematical methods have been developed to cope with this situation. It was initially decided to restrict the sample to the Electronic Research Center plus three other major NASA Centers. The Centers selected, because of their known interest in microelectronics, were the Goddard Space Flight Center, Marshall Space Flight Center, and the Jet Propulsion Laboratory. It was later decided to add the Ames Research Center to increase the sample size, but especially because the current utilization of microcircuits at Ames was lower than at the other three Centers. Including Ames made the test centers more representative of NASA as a whole.

It was decided to make the sample representative of an even wider diversity of potential interests by including a test center from outside the NASA Community. The Air Force's Rome Air Development Center in Rome, New York was added. Thus, six rather diverse Centers were included as test sites.

The basic approach was to set up a series of one- or two-day orientation sessions at each Center to brief the potential users on the mechanics of the system prior to the actual pilot test. Table II summarizes attendance. All of the attendees were not expected to actively participate in the Data Bank pilot evaluation, but they displayed a rather high degree of interest and enthusiasm at the orientation sessions.

TABLE II
RECORD OF ORIENTATION SESSIONS

NASA Center	Dates July:	No. of Sessions	Attendance
ERC	10	1	17
GSFC	11-12	5	67
MSFC	13-14	5	75
Ames	17-18	3	36
JPL	19-20	7	63
RADC	Aug. 7	1	22
Total		22	280

Anyone interested in the Microelectronics Data Bank Program was invited to attend the orientation sessions; there were no restrictions on the number of sessions or the total size of the attendees. It was later determined that although the majority of the attendees were from either the circuit design or reliability sections, a sizable number represented all other user groups.

The gross sample of 280 persons thus represented a random yet homogeneous group; these people, on their own volition, attended the session because they would be potential users of the Microelectronics Data Bank and had a need for its services. Further personal discussions with many of these attendees validated the fact that they did work in diverse user groups. It can be concluded, therefore, that a true random-stratified sample was available for analysis and that this factor reduced the size of the sample required to ensure a high level of confidence that they do indeed represent the population.

3. Assessment interview.--After the four-week pilot test, the contractor and the Technical Monitors conducted one- or two-day assessment interviews at each Center. The selection of participants to be interviewed was truly random: the interviewers talked to as many persons as were available at the height of the vacation period during mid-August. Table III shows the location, dates, and number of persons interviewed at each Center.

TABLE III
RECORD OF ASSESSMENT INTERVIEWS

Location	Dates	No. Interviewed
GSFC	August 14-15	20
MSFC	August 16-17	18
Ames	August 22-23	14
JPL	August 24-25	22
RADC	September 6	5
ERC	September 11	6
Total		85

The evaluation via personal interview proved to be a rather revealing and important exercise. After having been briefed on the mechanics of the system, and having had four weeks to think about it and use it, many of the people had interesting and valuable comments. Their personal interviews are summarized in Section VI of this report and their most salient comments are included in Appendix C. Names of the participants are not given in this report.

E. Statistical Method

Effectiveness of the Pilot Program in procuring a sufficient magnitude of user responses has been established. However, it has not been shown how representative this data is of the total population of potential Data Bank users. Before the actual responses themselves are analyzed, it must be proven that the magnitude of the sample size is sufficient to establish concrete statistical significance.

The proof is given in Appendix A, "Statistical Validity of the Sample Size." Appendix A shows that the sample size provides a very low standard error (less than four percent error) and that it can be stated with a 95 percent level of confidence that the viewpoints expressed by the sample are practically identical to the viewpoints that would be expressed by the total population.

The remaining sections of this report evaluate the usage responses received and viewpoints expressed regarding the Microelectronics Data Bank and its pilot test.

III. TECHNICAL EVALUATION OF DIRECTORY USAGE REVIEW RESPONSES

A. Distribution of Answers

The Directory Usage Review form is displayed as Figure 7. The first eight questions were structured to allow a "yes," "no" or "marginal" answer and can be subjected to a quantitative analysis. Questions no. 9, 10, and 11 are strictly comment type questions. The answers given to those three questions, plus comments made pertinent to any of the first eight questions, will be discussed in Section IV of this report.

All of the original usage review forms submitted by the pilot test users, and the summarization of the responses, have been forwarded to the Technical Monitor under separate cover. The numerical responses and the respective percentages are shown superimposed on the Directory Usage Review form, Figure 7.

Note that except for question no. 2 and question no. 4, 90 percent or more of the respondents answered "yes." Although at first glance this seems to be overwhelming, it is not the intent of this report to make broad generalizations or make inferences without offering some proof before stating a conclusion. For this reason, these responses will be examined further.

B. Confidence Level of Answers

The first eight questions pertain to the organization and adequacy of the proposed Directory to serve as an efficient desk-top book-form microcircuit Directory -- except question no. 2. This question is, "Did you find this Pilot Program Directory useful despite its limited coverage?" This is the only question that deals with the adequacy of the one-time Directory prepared solely for the Pilot Program. In order to examine a homogeneous group, question no. 2 should not be considered along with the other questions.

The total number of responses received from the 76 users, excluding question no. 2, is 532. Of these there were 477 "yes" responses -- a 90 percent ratio of affirmative answers. It is obvious from examining the questions on the Directory Usage Review form that the higher the number of "yes" answers the greater the assurance the Directory is adequate to satisfy users' needs for a book-form Directory.

The analysis is pursued further in Appendix B, "Statistical Analysis of Directory Usage Review Responses," where standard errors for each of the 8

DIRECTORY USAGE REVIEW - PILOT PROGRAM

DIRECTORY NO. 1 2 3 4 5 6

LOCATION 7 8 9 10

No.	Question	USER RESPONSE (PUT X IN ANSWER BOX) Yes	No	Marginal	If Answer is No or Marginal - Explain Below
1	Would a directory of similar format with more comprehensive coverage (i. e., fully operational system) be a valuable working tool for use at your desk?	68 89.5%	4 5.25%	4 5.25%	
2	Did you find this Pilot Program directory useful despite its limited coverage?	24 31.5%	25 33%	27 35.5%	
3	Is the categorical breakdown of digital integrated circuits satisfactory?	68 89.5%	0 0%	8 10.5%	
4	Is the categorical breakdown of linear integrated circuits satisfactory?	53 70%	4 5%	19 25%	
5	Within each functional category (i. e., flip-flops, etc.), are the characteristics summary headings adequate?	70 92%	3 4%	3 4%	
6	Is the overall organization of the directory and microfilm indices satisfactory?	71 93.5%	1 1.25%	4 5.25%	

Figure 7 Directory Usage Review Form

DIRECTORY USAGE REVIEW - PILOT PROGRAM

DIRECTORY NO. 1 2 3 4 5 6   LOCATION 7 8 9 10

No.	Question	USER RESPONSE (PUT X IN ANSWER BOX) Yes	No	Marg-inal	If Answer is No or Marginal - Explain Below
7	Is the information presentation logical?	73 96%	0 0%	3 4%	
8	Are the instructions for use of the directory clear?	74 97.5%	0 0%	2 2.5%	
9	What other integrated circuit characteristics would you recommend be included in the directory?	Please Comment: (26 COMMENTS MADE)			
10	What other types of integrated circuit information would you recommend be included in the directory?	Please Comment: (43 COMMENTS MADE)			
11	What suggestions can you offer to improve the format and usage convenience of this directory?	Please Comment: (40 COMMENTS MADE)			

Directory User's Name ____________
Group ____________
Extension ____________

Figure 7 Directory Usage Review Form (Concl'd) questions are calculated. Appendix B concludes that all of the questions attained less than a four percent standard error and that the data obtained from the sample represents the viewpoints of the total population of potential Data Bank users.

C. Differences of Opinion Among NASA Personnel

It was decided that a technical evaluation of the user responses should include an analysis to determine if there were any statistical differences among the reactions of user personnel at the six test Centers. This statistical analysis is performed in Appendix B on the basis of examining the difference in responses for each question by test Center. It was decided that a difference of opinion was significant only when it exceeded 30 percent.

The conclusion reached in Appendix B is that the difference of opinion among personnel at the test Centers is essentially insignificant.

IV. SUMMARY OF DIRECTORY USAGE REVIEW COMMENTS

The following summary has been derived from the 76 responses regarding the utility and effectiveness of the Directory. It consists of the comments on the 11 questions that appear on the Directory Usage Review form, which requested an explanation for each "no" or "marginal" answer. Figure 7 (Section III) shows the number of affirmative, negative, and marginal answers, superimposed on the form itself.

Question No. 1.--Would a directory of similar format with more comprehensive coverage (i.e., fully operational system) be a valuable working tool for use at your desk?

As previously explained, nearly 90 percent of the respondents answered "yes" to this question. Since a comment was requested only for answers other than "yes," only seven responses were received. The comments basically concerned the need for frequent updating, the possibility for improvement in format, and the fact that the Characteristics Summary Section of the Directory resembles a commercial characteristics tabulation.

The commercial service is neither widely accepted nor readily available to all potential users. Furthermore, the Data Bank Directory has significantly more information in it, has a format which is easier to read and use, and is essentially devoid of abbreviations and codes used throughout the commercial listing. Also, this listing does not provide the detailed in-depth information (available on microfilm and the computer query capability) provided by the Data Bank.

A significant comment on Question No. 1 suggested that the Microelectronics Data Bank should emphasize more the test and experience data which is hard to get and de-emphasize catalog data which is easily obtainable. Although this point is well taken, the ease of obtaining catalog data varies; some engineers expressed difficulty in obtaining catalog data that is timely and comprehensive.

Question No. 2.--Did you find this Pilot Program Directory useful despite its limited coverage?

This was the only question having a considerable difference of opinion. One-third of the respondents who found the Pilot Program Directory of no use made 24 comments. Most of the negative response was registered because the user either did not have occasion to use the Directory (during the test period) or had not consulted it because of its known incompleteness. A few users stated they were already familiar with the information contained within the Directory; but they were emphatic about the usefulness of a more comprehensive system.

Another major comment was the lack of an adequate amount of reliability information. Undoubtedly, more persons would have used the whole system and found the pilot products very useful had there been a greater amount of reliability data. One user suggested: "A reliability summary should be included in the Directory. This summary should include stress levels, field or laboratory environmental data, hours of operation, number tested, number failed, etc."

The usefulness of the Directory, as well as of the entire system, is obviously dependent upon the volume and accuracy of the data included. Accuracy of the data in the Directory was relatively high. Two-thirds of the respondents reported that the pilot Directory was immediately or marginally useful; this constitutes a very high degree of utility considering the relatively small volume of data.

Question No. 3.--Is the categorical breakdown of digital integrated circuits satisfactory?

Since nearly 90 percent of the respondents answered in the affirmative to this question, very little comment was offered. Of the eight persons who did respond, there were three meaningful suggestions: that pin compatibility, i.e., B+ and ground pins, be included; that a complete compatible series of logic functions be specified in addition to the characteristics given; and that in addition to organizing the microcircuits into ten sections an additional section be devoted to a list of the integrated circuits by circuit family, i.e., RTL, DTL, TTL, CTL, CML, MOS, MECL, etc. The engineer who submitted the last suggestion included examples with his response.

Question No. 4.--Is the categorical breakdown of linear integrated circuits satisfactory?

Although 70 percent of the critics responded with a "yes" answer, only five percent responded negatively; the remaining 25 percent were marginally satisfied. The small negative response precipitated only nine comments. The most important were: details should be more comprehensive (recommend considering the EIA format); characteristic curves are important elements in selecting linear circuits; amplifiers should be broken down into operational, differential, RF/IF, video, small signal, etc.; linear circuits should also be organized by circuit family; should show whether information is available on compensation circuits; linear circuits are more difficult to search out than digital; therefore, more information should be available; should include voltage and current offset along with temperature information on these offsets; essential parameters are input bias current and current drift, differential input current and output current at maximum output voltage.

Phraseology was questioned by one user who suggested, "The digital and linear dichotomy is incorrect. The usual terms are linear and non-linear or analog and digital. The latter is probably the best terminology."

An analysis of the responses to Question No. 4 indicates that there is considerable room for improvement and expansion of linear characteristics beyond those included in the pilot Directory.

<u>Question No. 5.</u>--Within each functional category are the characteristic summary headings adequate?

The responses to this question amounted to 92 percent affirmative with only six comments. The salient comments were: for reliability purposes, type metalization and bonding materials used would be helpful; more comprehensive information is desirable; for linear circuits, clarification is needed as to the voltage level implied for the three db bandwidth and whether output voltage is the maximum; it would be desirable to know B+ range, i.e., 4.5v to 8v, as a guide to circuit compatibility.

The characteristics summary headings appear to be adequate, although some "polishing" may be necessary.

<u>Question No. 6.</u>--Is the overall organization of the Directory and microfilm indices satisfactory?

The "yes" response to this question was over 93 percent, and there were no meaningful comments.

<u>Question No. 7.</u>--Is the information presentation logical?

This question amassed a 96 percent affirmative response and no meaningful comments.

<u>Question No. 8.</u>--Are the instructions for the use of the Directory clear?

Over 97 percent thought the instructions were clear, and no meaningful comments were given.

Question No. 9.--What other integrated circuit characteristics would you recommend be included in the Directory?

This and the following two questions were not amenable to affirmative or negative opinion; any response had to be in the form of a comment. As a result, 26 respondents elected to comment on the desirability of including additional characteristics.

Additional characteristics recommended were: metalization and bonding; shock testing and the number of G's applied on each circuit; drift and offset characteristics; typical and/or maximum weight for each package type; internal measurements of components in the IC's for failure mode analysis; price information, pin designation B+ and ground; and device construction data.

It was also suggested that symbols and abbreviations be standardized. This suggestion, emanating from RADC, pointed out that such standardization has been established by RADC and that the Data Bank could adopt this standard.

Question No. 10.--What other types of integrated circuit information should be included in the Directory?

This question brought more response than any other: 43 persons (57 percent) elected to comment.

The important comments follow: program mission usage and experience with the device; failure modes and rates; indication of the number of reports available per device rather than an asterisk; cost data; device package outlines; end use environment, such as ground, airborne, booster, satellite, etc.; indications as to whether screens and burn ins are included in the in-depth information; indiation if a voltage different than that specified by the manufacturer could be used and what would happen if a different voltage were used; internal measurements of components for failure mode analysis.

Additional comments include: a summary of qualification tests performed by various companies throughout the industry and a contact identified within each company leading directly to the qualification test descriptions and results; valid applications experience from other users; overall expansion to include more than integrated circuits (discrete parts); more information on linear circuits; expansion to include CTL, MOS, MECL II, MTDL, etc.; the addition of large-scale integrated functional blocks, such as shift registers, multiplexers and D/A networks; in addition to propagation delay and rise/fall time, must also know conditions under which they were measured and the loading capacitance; related hardware commonly used with microcircuits; and numerous comments relative to the need to focus attention on reliability, test, and in-depth information.

Some of this requested additional information is not intended to be included in the Directory. The user will be directed to this information in full text form via the microfilm indices. These comments, however, indicate the need for this information and suggest that additional efforts be expended in putting as much information into the Directory as is economically and technically feasible.

Question No. 11.--What suggestions can you offer to improve the format and usage convenience of this Directory?

This last question on the Directory Usage Review form encouraged 40 responses from 53 percent of the respondents. Suggestions include: a section devoted to the comparison of demonstrated versus predicted operational and reliability figures for a given device; the incorporation of methods indicating the absence of data on a specific device as early as possible in the Directory; telephone request service for hard-copy printouts of full text material existing on the micrographic file; stress on environmental test data; more data analysis to show circuit reliability as a function of electrical stresses; constant updating and indication of discontinued lines and dates of discontinuance; cost data or cost ranges for a specific device; establishment of standardized definitions; a very comprehensive bibliographic section entirely devoted to valuable reports on microelectronics.

Additional comments were: overall expansion to include more than just integrated circuits; notations as to who is working on what; in order to maximize the use of the microfilm file, it should be very accessible to the users; Data Bank should evaluate the "worth" of data; the system should contain and maintain a cross index of the numerous numbers assigned to a particular device; the Directory should indicate how many reports are in the system for each microfilm category; inclusion of integrated circuit family types; lists of individual manufacturer's product lines; primary emphasis on new circuits; inclusion of a circuit classification scheme similar to Figure 2 in "Microcircuit Line Certification" document of the Subcommittee, dated June 1967; abstracting long reports and microfilming the abstract rather than the entire report.

In addition to commenting on the review form, several persons forwarded memos commenting on the Directory and/or the overall system. The following are excerpts from them. (The entire set of memos has been turned over to the Technical Monitor under separate cover.)

"The Data Bank should expand in the area of inventories, listing which NASA Center has bought what microcircuits, including custodian, quantity, and location. This information is vital for mutual exchange of the items as well as experience. In addition, item traceability is necessary for reliability reasons in this rapidly advancing technology."

"Caution should be used in weeding out reports of doubtful contents. Questionable reports should be passed on with a respective comment of the contractor evaluator."

"Engineers here seem to be generally impressed with the ideas incorporated in the Data Bank. Major criticisms were that not enough reliability or use history data was available.... While considerable interest was expressed in a comprehensive, operational Data Bank, no one wanted to waste time on an operating model."

"The Microelectronics Technical Data Bank Program presented by Information Dynamics Corporation to ____________ Center has much merit. We in the reliability and quality assurance branch at ____________ Center are convinced that this type of program would be of great benefit to NASA." Several comments of this nature were received but will not be duplicated here.

"The information which would be of most use would be current (last year and a half) usage history data. This should include application idiosyncrasies (loading, speed, etc.) not noted by vendor on his catalog sheets. Reliability information is needed including incidence and modes of failures and failure mechanisms. It would be helpful to have the identification of users for detailed personal communication. In my opinion, the Data Bank will not work if you depend entirely on users to submit information to you. I would expect less than five percent response and two years behind. This must be <u>actively</u> pursued by the administrators of the program through review of purchase orders of the Centers, DOD, <u>et al</u>, with follow-ups to individuals on a call or visit basis. This, obviously, is a <u>major</u> task in itself."

V. TECHNICAL EVALUATION OF THE MICROGRAPHIC FILE AND COMPUTER USAGE REVIEW RESPONSES

A detailed analysis of the Directory Usage Review responses was necessary because the Directory represents the first level of access into the system; the Directory is the "heart" of the Data Bank. The other two major output products -- the micrographic file and the computer query capability -- need not be examined in quite as much detail. The utility and practicality of both cartridge microfilm files and computer-based query systems have been proven by numerous other information systems employing these techniques.

In spite of this observation, some analysis of the microfilm and computer-based files is necessary to identify specific problem areas and areas needing improvement. Valuable insights into these areas were gained from the personal interviews with 85 users of the Pilot Program. Summaries of their comments are included in this Section, while the complete text of the interviews appears as Appendix C.

Use of the computer and microfilm files by engineers was limited. Apparently, engineers felt the Data Bank, as an operating model, held insufficient data to be reliable in actual design work. While considerable interest was expressed in a comprehensive, operational data bank, few wanted to waste time on an operating model. However, in spite of this reluctance, enough engineers <u>did</u> use the micrographic files and the computer query capability for a meaningful technical evaluation.

A. Evaluation of the Computer Query Capability

1. <u>Computer queries</u>.--During the Pilot Program the computer was queried 38 times. Thirty queries came during the six-week test and eight during the orientation sessions. As shown by the detailed record of computer queries (see Appendix D), 36 of the 38 requests (95 percent) were answered via telephone in 30 minutes or less, one was answered in an hour, and one was answered the next day (the query originated near the close of the working day).

The requesters did not receive the responses quite as fast as indicated on Appendix D because, during the pilot test, the response was relayed through ERC in order to utilize the FTS (Federal Telephone System) network. However, the exact time for the complete circuit (from requester to Data Bank to ERC and back to requester) was known for the eight live demonstrations. Using FTS, the responses were received in about 15 minutes in all cases except one.

It is clear from the record that the computer query capability responded swiftly to all requests and, in spite of inherent problems with the FTS network, was successful in rapidly relaying the answers.

2. Computer query review responses. --Of the 30 engineers who submitted a computer query, usage responses (written and oral) were received from 22. These responses are summarized in Figure 8 and are discussed below.

a. Question 1. --Was your query answered to the level of specificity required for your use? All 22 respondents answered "yes." Note that even those who were unsuccessful in finding circuits to match the given search parameters answered in the affirmative. This result implies that from the orientation sessions they knew what to expect and were agreeing (whether or not they received a printout) that the level of specificity was adequate.

b. Question 2. --Was the printout format satisfactory? Fifteen respondents (68 percent) replied "yes." The remaining seven did not answer the question because they did not request, or receive, a computer printout. All who did receive a printout agreed that it was satisfactory.

A typical printout appears in Figure 9, along with the input as keyed in at the console typewriter. This query asks for binary or flip-flop circuits, manufactured only by Fairchild, with a logic type equal to DTL, a noise immunity greater than or equal to 500 mv, a power supply equal to 5.0 volts, and a temperature range of -55°C to +125°C. The part description and package configuration are to be printed out for all circuits meeting the above criteria. According to the printout, five Fairchild circuits in the computer files satisfy these characteristics. (A complete explanation of the computer routines involved in a query appears in Volume III.)

c. Question 3. --Did you receive the answer to your query within a satisfactory period of time? Nineteen (86 percent) of the responses were "yes." Three users (14 percent) indicated "no": one from the only user who received the answer the next day; the other two negative responses were in favor of on-line immediate response.

d. Question 4. --Did you find the computer services provided in the Pilot Program (although limited in scope) useful? Sixteen users (73 percent) answered "yes." Five users (23 percent) answered "no" and one user (4 percent) found it marginally useful. A 73 percent usefulness factor is a respectable figure considering that only 20 percent of the existing microcircuits were included in the computer files during the pilot test.

e. Question 5. --What types of data and information services would you recommend be provided by the computer in an operational system?

REQUESTER ____________

GROUP ____________

TEL. EXT. ____________

Location: 1 2 3 4

Query Request Date: 5 6 7 8

Answer Received Date: 9 10 11 12

No.	Question	USER RESPONSE (PUT X IN ANSWER BOX) Yes	No	Marginal	If Answer is No or Marginal - Explain Below
1	Was your query answered to the level of specificity required for your use?	100%	0	0	
2	Was the printout format satisfactory?	68%	0	0	Note: Remaining 22% did not answer since they did not request, or receive, a printout.
3	Did you receive the answer to your query within a satisfactory period of time?	86%	14%	0	
4	Did you find the computer services provided in the Pilot Program (although limited in scope) useful?	73%	23%	4%	
5	What types of data and information services would you recommend be provided by the computer in an operational system?	Please Comment: Numerous written and oral comments were made -- see text.			

Figure 8 Computer Query Review Form

MICROELECTRONIC DATA BANK CIRCUITS - DIGITAL

MFR NAME	PART NO.	SECT	LOGIC TYPE	NOISE IMMUN	2 SPPLY VOLTS	MIN TEMP	MAX TEMP	DEVICE FUNCTION	PACKAGE CONFIG
FAIRCHLD	DTL931	1	DTL	600	5.0	-55	125	CLOCKED RS FLIP FLOP	TO-88
FAIRCHLD	DTL945	1	DTL	600	5.0	-55	125	CLOCKED RS FLIP FLOP	TO-88
FAIRCHLD	DTL948	1	DTL	600	5.0	-55	125	CLOCKED RS FLIP FLOP	TO-88
FAIRCHLD	DTL950	1	DTL	600	5.0	-55	125	CLOCKED RS FLIP FLOP	TO-88
FAIRCHLD	LPDT9040	1	DTL	700	5.0	-55	125	CLOCKED RS FLIP FLOP	TO-88,DIP

END OF JOB

DATA BANK QUERY

```
section e 1
mfr-name e fairchld
logic-type e dtl
noise-immun ge 500
two-volts e 5.0
min-temp le -55
max-temp ge 125
part-dscrip ne junk
pack-config ne junk
end
```

CONSOLE INQUIRY

Figure 9 Typical Console Query and Computer Printout

Since this question precipitated a large number of comments -- both written and oral -- and since the answers are interrelated with comments on the overall computer query capability, extracts from the responses are summarized into the three categories -- utilization, turnaround, and suggested applications -- which are discussed immediately below.

3. Computer utilization. --The following important statements were made regarding utilization of the computer query capability:

* As a designer, I would use the computer query capability.

* Having one phone number to pick up to determine usage experience of others is a very valuable asset.

* I performed a computer query and got very quick results. The mechanics of the Data Bank are fine but the data itself was not too useful.

* I would use the system. The computer query would be used; not often, but valuable when we need it.

* The computer hard copy sent to the inquirer should include a configuration of his inquiry or plan of research to assist him in restructuring his query if need be.

* The idea of a computer query is good. It would save the designer several days of searching if the computer could give him circuits which meet stated criteria.

* I interrogated the computer. On the first try my specifications were too tight and received no matches. Then I relaxed the parameters and got several matches that provided some useful information to me.

4. Computer access and turnaround. --The following summarization represents major viewpoints:

* Talking to an analyst at the other end of the telephone is a good idea; I have tried it the other way and it doesn't work. It is hard to justify paying for direct access.

* Having someone at the other end do the search and initial analysis work would be a significant time saver to me.

* I would not object to calling a local man who would collect all queries and relay it to the computer; this would save me time in making the telephone call myself.

* I prefer an interface with an analyst; the computer is stupid. Short response time is very important.

* Telephoning the computer may be cumbersome because sometimes it takes me over one hour to get a line through when I am using the Wats System.

* In the long run, I would prefer direct computer query. Routines would have to be written to translate a single request to a complex computer query.

* The computer is the most important link in this system. The analyst is a vital element as he provides an effective interface.

* I did not mind the delay in mailing the computer output because it takes me just as long to get an output from our own computer.

* Twenty-four to forty-eight hour feedback is okay since it sometimes takes weeks to get information now.

* A query response within twenty-four hours is perfectly adequate.

* The Data Bank is a good idea, but to maximize usefulness it should utilize a time-sharing technique in order to shape your query through a man-machine interchange. I do not think the lead time is short enough on a telephone query; the time lag is significant. In general, in our area the answer is usually in the form of a matrix which is not amenable to oral communication.

5. Computer applications.--The most important suggestions about expanded applications of the computer query capability are as follows:

* The computer could provide an Information Analysis System because there is a lot of complicated computation resulting from the many variables existing. The computer could recognize various types of failure modes for obtaining reliability statistics. It could determine when the process of manufacturing has changed. The computer could be a very useful aid.

* An expanded system providing computer-aided design capabilities would be very useful.

* I would also like to see logic minimization programs in the area of computer-aided design.

* In designing the search criteria it would be better to ask the inquirer to distinguish "must" characteristics and "desirable" characteristics. This approach will provide him with more information and provide a better service.

* Some scheme for inclusion of cost data should be made. With cost information you could have a trade off with "must" and "desirable" characteristics in selecting circuits. A price range would be a useful ball park number.

* The computer could probably help out in preparing reliability models. EIA is doing work on modeling and a contractor is doing work for us in this area.

* The trend of reliability with time is nice to know for top-level planning. By this I mean some correlation between reliability of a device and how it is put together. The computer could probably help out here.

* One-third of my time is spent determining whether the test data is good or bad. Fifty percent of the tests are bad. Fast tests with high accuracy is virtually impossible. A computer could definitely determine if the test data is good since we do that now manually. Standards are used to select the good data. We have a great amount of data collected but retrieval is rather difficult.

* Every day I get "three pounds" of data on failure. I cannot possibly digest all of this. Others get this volume of information also. We need a computer system in order to put this information away and a system of being able to get it out when we need it.

B. Evaluation of the Micrographic File Usage

Many approaches to microfilming were studied thoroughly during the original design study, see Ref. (7), prior to determination of the best technique for disseminating the anticipated large volume of full text reports. Each of these approaches was compared to a set of requirements. The cartridge system was selected as the best available: most of the user groups were already familiar with the use of microfilm cartridge systems (VSMF, ASCAM, etc.); its practicality had been already demonstrated; and some cartridge reader/printers already existed at the NASA Centers.

Users of the microfilm files during the pilot test (and there were many) were supposed to make entries in a log book after completing their searches. Unfortunately, because of the physical set up at the Centers, and the impracticality of continuously manning the reader/printer station by the on-site monitor, these logs were not used. However, the personal interviews with micrographic file users provided the following significant comments, enabling an evaluation of the utility of these files to be performed:

* I performed an exercise with the microfilm files and was pleased at the amount of information available. I found it quite useful. I also liked the speed of retrieval.

* The microfilm file is the most important element of the Data Bank; it may replace one of the existing systems in microelectronics.

* The microfilm system is okay but I had trouble using the hand crank reader/printer available during the pilot test.

* Proximity of the microfilm is important if it is to be used.

* I did try out the microfilm file and found no problem in using it.

* The decentralization of people at our Center presents a problem with the microfilm files. There would have to be three to four microfilm files set up here.

* Use of the microfilm files should not present any problems.

* Reports, especially long reports, could be prejudged and an abstract of these reports included so the user would not have to read the report on the microfilm reader.

* A good index to the microfilm file is extremely important. The microfilm index on microfilm itself is not useful.

* The main advantage of the microfilm file is that someone else keeps it up to date for you and you maintain file integrity because no one can run off with your file.

* Color pictures are sometimes important in working with microcircuits. The microfilm should have color pictures if the picture shows some information not readily observable in black and white.

An additional application recommended in a memo from one of the Centers was: "In reviewing the entire program concept, there is one major point which should be taken into consideration. The geometry of each integrated circuit should be photographed and monitored for changes in geometry and processing technique. It is our recommendation that the geometry be controlled so there will be a sound basis for qualification programs. This function should be a part of the total Microelectronics Data Bank."

As a result of these comments by users of the microfilm files, it is concluded that the original design choice was correct and that the micrographic system selected does perform the required function of full text dissemination.

VI. SUMMARIZATION OF PERSONAL INTERVIEWS

During the field assessment task, 85 persons were interviewed by the contractor's representative and the Technical Monitor. This exercise proved to be an educational, revealing, and worthwhile effort. Although validation of the system's acceptance was derived primarily from a statistical evaluation of the written usage review forms, the value of the personal interviews should not be understated. The suggestions are important since they represent the need for specific types of information services. The feelings expressed are even more important, because they give a true insight into the user's acceptance of the system -- the key to success or failure.

Verbatim extracts from the personal interviews have been summarized and are presented here, grouped into seven major categories: interfaces with other systems, data needs, data bank design, directory utilization, cooperation among NASA Centers, currency and validation, and general. Complete transcripts of the interviewee comments appear as Appendix C to this report.

A. Interfaces with Other Systems

General comments made relative to interfaces with other information systems include:

* Microelectronics is important enough to warrant a separate Microelectronics Data Bank.

* Cooperation between the systems should take place from the start in order to minimize duplication and maximize the usefulness of the information interchange.

* The system should be utilized outside of the NASA community because with more users you will get more input and more support.

Regarding the commercial tabulation, a frequent comment was:

* The Data Bank is far better, because it gives information in greater depth and more detail.

The interviewees at RADC agreed that:

* There would actually be very little duplication of effort between the Data Bank and MIAC (Microelectronics Information Analysis

Center). MIAC is concentrating on Air Force systems; the Data Bank would be concentrating on NASA systems. The only duplication would result in covering joint NASA/Air Force projects but this could be controlled in order to avoid duplication.

Among the comments made relative to PRINCE/APIC and the Data Bank were:

* Currently, the amount of microcircuit data in PRINCE/APIC is small. In the area of microelectronics, PRINCE/APIC would certainly benefit from a cooperative agreement with the Microelectronics Data Bank, and PRINCE/APIC would be able to provide the Data Bank with information it obtains from DOD sources not readily obtainable by the Data Bank.

* Future reports on the Microelectronics Data Bank should outline the interaction of this data center with other data centers. Duplication of efforts should be minimized right from the beginning.

* Just three percent of the data contained in PRINCE/APIC deals with microelectronics. This area could be greatly expanded through cooperation with the Microelectronics Data Bank. PRINCE/APIC must and does cooperate with other data banks in order to enhance its usefulness to its users.

* There is a great deal of difference in the overall design, approach, and content of the Data Bank versus PRINCE/APIC.

The on-site Monitor made this written comment:

* "Discussion with representatives of the PRINCE/APIC data center revolved primarily about the common criticisms that the Microelectronics Data Bank would be a duplication of PRINCE/APIC's effort. After examining the question in detail, however, it became apparent that a Microelectronics Data Bank would actually be a valuable complement to PRINCE/APIC, and their representatives expressed considerable interest in cooperating with an operational data bank, by exchanging information and by offering organizational and operational advice."

Comments related to a current system:

* We use it a lot. As a result of this use, our hard-copy file is being cut down.

* I currently use this system to determine if there are any reliability reports on circuits that engineers want me to test. I have found the system very useful in the past.

* It is not complete enough; there is not enough detail about what parameters are used.

* The process of filling out summaries is too time consuming and we enter only the information we have to.

* It falls short because the data is too old to be useful.

B. Data Needs

At least 25 percent of those interviewed commented on the critical need for reliability data. Typical comments were:

* The most useful part is reliability information not generally available elsewhere; I would really like to see such data.

* The system seems well designed and I would definitely use it if it had reliability data.

* Emphasis should be placed on reliability and usage data; this information is needed badly.

Other comments related to data needs:

* The manufacturers' data sheets have many gaps of information. We need the manufacturers' in-depth data to see the total graph of the curves, not just particular points or averages.

* Of importance to me are the failure modes. This information would indicate the proper types of screens to be employed.

* Raw test data is not useful in itself; some work or reduction of this data should be done. Environmental test data is of most use to us.

* Detailed specifications and in-depth data will be of great value to me and this entire branch.

* We also need cost data. A cost range would be acceptable.

* For each circuit I am interested in I would like to know the set up for the burn in (in-depth data) as well as field data on results of user experience. The two together would really be something. This kind of service is not available anywhere else.

* If you can collect timely qualification and reliability reports on new microcircuits, it would amount to somewhat of a breakthrough.

Specifically related to catalog data sheets were these comments:

* The system is a good idea even if it is just a good source of manufacturers' data sheets, because they are sometimes hard to get. In addition, it is time consuming to organize these sheets and keep them up to date.

* It is very expensive and duplicative to have everyone collect catalog data.

* Generally we do not rely on catalogs because we do not have the time to keep them up to date.

* The system must be timely, fast and complete if it is to be a success. I have had to wait from six to eight weeks for receipt of manufacturers' data sheets.

* I have a need for this system. I currently keep a set of about 20 manufacturers and I update them when I receive updating material.

The overall need for data was summed up by one NASA engineer as follows:

* Producing quality circuits is not an exact science but certain things can be done to ensure good circuits. The thing that really counts is how well the circuits are built. The manufacturing quality is an unobservable thing to NASA. The Data Bank can provide a very useful service if the reliability reports and the certified lines listing will help us understand what is going on inside the manufacturing plants.

Practically everyone interviewed stated there was a definite need for the system. Typical comments were:

* There is a tremendous need for this system since a great deal of interface time is spent with component engineers in acquiring data.

* There is a desperate need for a system such as this, and I am sold on the idea of the Data Bank.

* There is a definite need for this system, particularly in light of the rapid changes in technology. In this type of Data Bank you can be flexible enough to keep pace with changing requirements.

* We want the Data Bank; indeed, we need it rather badly.

C. Data Bank Design

A frequent comment made relative to the overall design was:

* The system is well designed and, if the data can be procured, it should be an often used system.

Many commented that the Data Bank system design approach was quite similar to the methods they currently follow in selecting microcircuits:

* The overall design approach is a good idea; the system scanning feature gives the broad scope to give an overview orientation, then the detail is available for looking up specifics -- this is a good approach.

* The system layout of the Data Bank is a definite match with respect to our operational problems.

* The Data Bank is designed in such a way that it matches exactly the logical approach we would normally employ in selecting microcircuits.

Additional comments relative to the Data Bank design:

* The Data Bank should not be hardware or organizationally oriented. It should be modular in construction.

* If I have to fill out paper work in order to obtain the information, chances are I would not use it. It must be easy to use with little or no paper work involved.

* The Data Bank design is so sound that we are setting up a data system on contractors at this Center patterned after the Data Bank design.

* One current system has a general information category. The Data Bank should also have a general reliability section for reports not concerned with a specific microcircuit.

* To decrease the time between performance of a study and publication of the results, the Data Bank could refer queries to locations where the study is being conducted in advance of publication.

* It would be desirable if the Data Bank could provide a hard-copy service for longer reports which you would not want to put on microfilm.

D. Directory Utilization

Numerous comments were made regarding the adequacy of the organization of the Directory. In addition were the following pertinent comments:

* The desk top Directory is a valuable tool to the design engineer; he would be foolish not to use it as a handbook to help him do his job.

* The Directory should indicate, insofar as possible, that a circuit can operate under different voltages.

* It would be a good idea to have a group of experts normalize the input data so as to make it most useful. Since the information currently is not normalized, going into too much detail in the Directory would not be gaining much.

* The Directory located on my desk is an excellent idea; it could be very influential in decision making.

* There is not enough information or knowledge disseminated about circuits available from the smaller manufacturers. The Directory would greatly help out in this area.

* Price ranges, rather than exact prices, could be included in the Directory. This will help in doing cost effectiveness studies. With this information the Directory would be consulted even more.

E. Cooperation Among NASA Centers

One of the most important areas discussed was the necessity to assure cooperation and the exchange of microcircuit information among NASA Centers.

* To do our job properly, we need data on microcircuits that has been compiled by other Centers. We cannot, alone, do all of the screening necessary.

* We need the cooperation of other Centers in the purchase of high reliability microcircuits. Last year, we purchased 20, 000 microcircuits. This purchase is not large enough for us to get the kind of data we wish to have.

* When a new circuit comes out I always want to know how many others have used it, tested it, and what were the problems associated with it.

* There is an important need to know about research going on elsewhere in NASA. There appears to be a lot of duplication of effort not only throughout NASA but within our Center as well. In several NASA Centers persons are not aware of the research going on down the hall.

* We want to know what everyone else has been doing. Thousands of dollars are spent in travelling around obtaining this information on a continuing basis.

* There are not many people here working on reliability; we have a small group. We could greatly benefit by the input from the reliability activities being conducted at other Centers.

* We do a lot of testing here but budgetary restrictions make it impossible to test everything. We could capitalize on test results from other Centers.

* We cannot rely on manufacturer provided information; if someone in the field has run a test (NASA or DOD) we want to know about it.

* Most circuit designers know what circuits are available, but they rely primarily on those circuits they are already familiar with and frequently overlook other circuits that are better. The Data Bank would make it possible to conduct a thorough search.

* We would also like a reference service indicating who is working on what studies; for example, which laboratories are doing specific studies on failures and failure modes.

* The success of the system is dependent upon the participation of the members; the greater the participation, the more successful the Data Bank will be.

F. Currency and Validation

The necessity for timely and accurate data was reiterated many times by the interviewees. They expressed a belief that the system will not be successful if the data is not timely:

* A communication system is needed badly to get information in fast. There must be some type of organized system or network for reporting this information.

* Rapid access to information is very valuable. The advantages to us are really great.

* It is important that data on a new circuit get into the system as soon as possible after the circuit comes out; the Data Bank must be current. Most of the other information systems contain old data of little interest.

* The circuits we ultimately select and use usually are not optimum because we do not have the time to devote to a total search of available circuits to meet our needs. The Data Bank would provide a tool to conduct a complete search. There is a definite need for this system; most other systems do not contain timely information.

* In order to be successful the Data Bank must provide quick response, be up-to-date, and be very complete.

* We need a system that stays up with the state-of-the-art. The average NASA Center cannot keep up because, based on my experiences, it would take about 120 people to keep up with the state-of-the-art on integrated circuits.

The need for evaluation and validation of the input data was expressed as follows:

* It is imperative that every effort be made to assure that the data put into the Data Bank is valid.

* Publications of invalid data, no matter how small, will severely damage the reputation of the Data Bank.

* Sufficient effort at the front end of the system, the data collection, will make or break the system.

* The Data Bank must have parts or components specialists and reliability engineers to perform analyses and draw conclusions. This brings up the question, "Can the Data Bank get away with advertising negative information about products?"

* The Data Bank must be accurate and comprehensive in order to be successful. Users' confidence must be obtained before they will use it.

* The Data Bank must do some type of analysis of the data to make it most useful. The system would be a good source for developing and updating models or tradeoff procedures needed to determine reliability of a device.

G. General Comments

The following comments were of a general nature:

* What the Data Bank is attempting to do is a lot of work but we must start somewhere. We can't say it is too big a job, so let's not tackle it. Something must be done.

* Lots of information may not find its way into the system unless a formalized failure reporting system for submitting information is instituted.

* Today, information is obtained basically through personal contacts. It took me eight years to prepare my two "black books" of personal contacts without which I could not obtain the information I need.

* The Government needs a standardization of stress level environmental factors so as to facilitate interrogation of the Data Bank.

* Personally I am very much in favor of the system and think it is a big step forward.

* A system with full capabilities would have great possibilities.

* A while back I made 15 telephone calls in a three-day period to obtain data that would have been readily obtainable from the Data Bank in a matter of minutes.

* The Data Bank would be both a time saver and a money saver.

* People are basically reluctant to give up information; therefore, personal contacts are the only way to get the information.

* We need data even though it may be somewhat unreliable and/or misleading. Let me decide if it is valid or not.

* The idea of the Data Bank is great -- you are doing part of the designer's job for him and probably better because he does not have the time to do a complete search.

* The biggest payoff for the Data Bank would be in the area of linear circuits, particularly linear applications data.

* Analyses by contractors are biased; a central source for collection and analysis is better and more complete.

* This system could be a leader in the area of standardization, particularly in standardization of parameter definitions. It is quite conceivable that the Data Bank could become a very popular information system.

APPENDIX A

STATISTICAL VALIDITY OF THE SAMPLE SIZE

The method of assuring that the participants in the assessment were representative of the total NASA community is described in Section II. D. The following discussion begins with the understanding that the sample was selected by a "randomly-stratified" method, was organizationally and geographically diverse, included representation from most of the user community, and that the opinions expressed were honest and unbiased.

1. Sample size. --It can be shown that the sample size represents a rather high level of confidence that the opinions expressed coincide with the opinions of the total population of potential users. The actual number of potential users is unknown; it is an ever increasing number due to the rapidly expanding application of microcircuits to space vehicles.

In analyzing statistically collected information, precise knowledge of the population size is frequently unknown. However, there exist mathematical methods of determining confidence levels without any knowledge of the exact magnitude of the population. Foundation for the following analyses was derived from Chorafas (Ref. 1), Cramer (Ref. 2), and Duncan (Ref. 3).

Attaining extremely high confidence levels can become a rather expensive affair due to the large number of samples needed. This is in part due to the fact that the reliability of a sample is not directly proportional to its size. The reliability of a sample increases directly with the square root of the number of items in it, e. g., increasing the sample size from 16 to 64 reduces the sampling error by half (by comparing the square roots, four and eight). To reduce the sampling error again by half would require a sample of 256 (square root is 16).

2. Statistical method. --A common statistical method to determine the proper size of a sample consists of, first, specifying the amount of error that is desired (or allowable) and then calculating the size of the sample needed to give this level of confidence. This method requires knowledge as to the occurrence or "incidence" of the event, commonly referred to as the "fraction defective." In our application, it is equivalent to how many persons answered a question with a "yes."

This entire approach is based on a proven statistical truth that for relatively large samples the "characteristics of the sample" serve as an accurate estimate of the "characteristics of the population" from which the sample was derived. For moderately sized populations (about a thousand), most statistical textbooks consider a sample of 30 to be large. Therefore, it may safely be stated that the approach to be used is applicable to this situation since the sample of 76 Data Bank users is relatively large.

It is shown by Chorafas (Ref. 1, pg 176), Cramer (Ref. 2, pg 208), and Duncan (Ref. 3, pg 372), that for large samples, the standard deviation of the sample is an accurate estimate of the standard deviation of a corresponding population and the following formula is derived:

$$S_{p'} = \sqrt{\frac{p'(1 - p')}{N}}$$

where $S_{p'}$ is equal to the percent error allowable (known as the "standard error" of a sample proportion), where N is the sample size and where p' is equal to the incidence of an event.

3. Level of confidence.--Ninety percent of the user responses were in the "yes" category (see Appendix B). With a sample of 76, and an occurrence (or incidence) of 90 percent, what level of confidence do we have that the total population (the total number of potential users of the Data Bank) would express the same opinions?

Using the formula above, it is possible to draw the graph shown as Figure 10. The incidence (p') is .90 and the allowable errors ($S_{p'}$) were plotted from one percent through five percent. As shown on the figure, the standard error for our sample of 76 is 3.6 percent.

Figure 10 indicates that a standard error of two percent would have required a sample size of 225. Although statisticians favor the two percent error level, it is believed that the 3.6 percent error in our responses is small enough to establish a very high degree of reliability on the validity of the data collected.

Our sample responded 90 percent in the affirmative. We may now ask, what degree of assurance do we have that the total population of potential users would also answer 90 percent affirmative. This is normally done by selecting the level of confidence we wish to maintain and then calculating the upper and lower limits we could expect from the total population.

To be specific, let us say that we wish to maintain a level of confidence equal to 95 percent. This is reasonable since our standard error does not exceed four percent. It is shown by Duncan (Ref. 3, pg. 351) that for a 95 percent confidence level the confidence limits can be determined by adding to or subtracting from p (incidence) the following quantity:

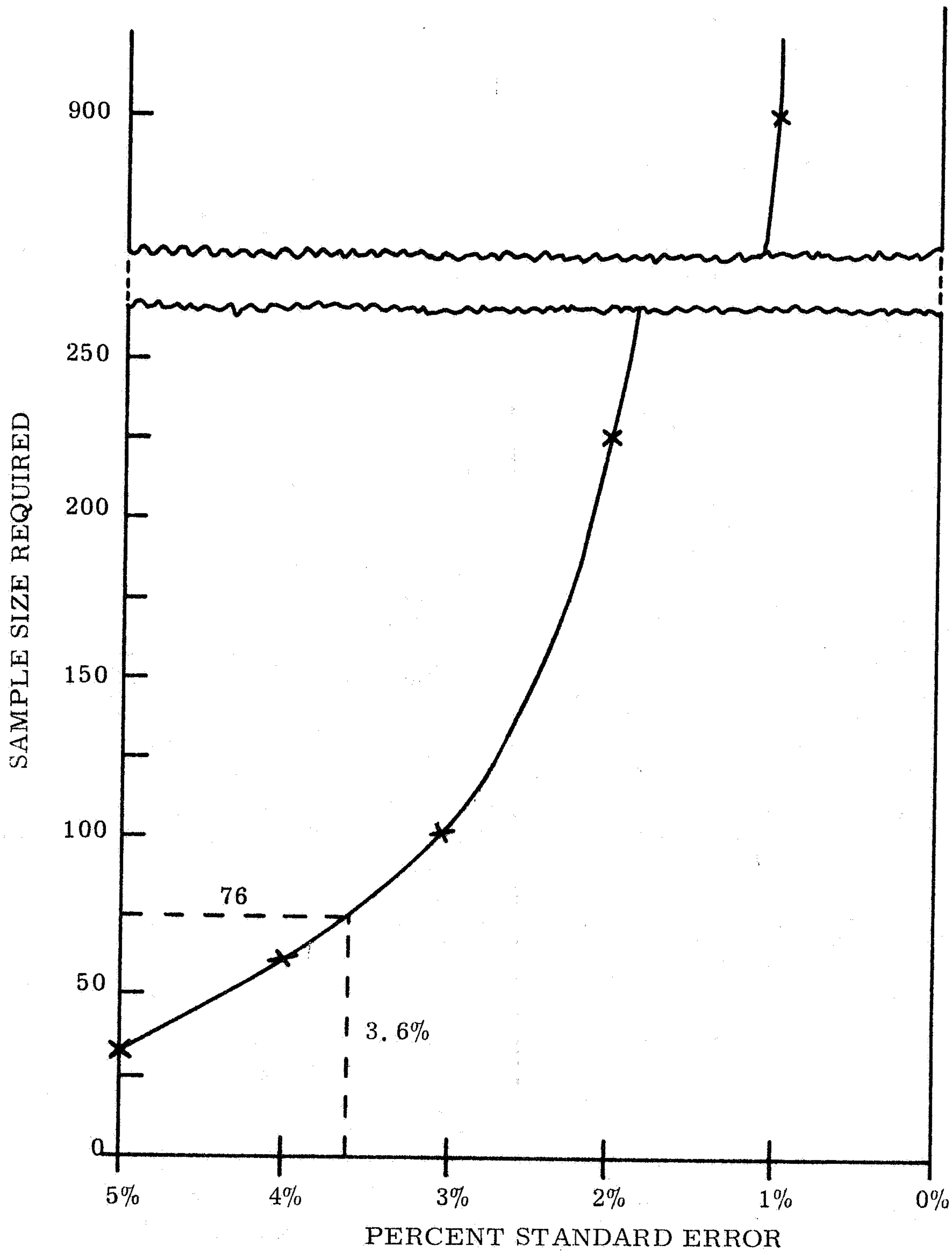

Figure 10 Sample Size Required Vs. Standard Error for a 90% Incidence Factor

$$2\sqrt{\frac{p\,(1-p)}{N}}$$

The mathematical statement is

$$\text{Prob.}\left(p - 2\sqrt{\frac{p\,(1-p)}{N}} \leq p' \leq p + 2\sqrt{\frac{p\,(1-p)}{N}}\right) = .95$$

which in our application becomes

$$p' = 0.9 + 2\sqrt{\frac{(0.9)\,(0.1)}{76}}$$

$$p' = 0.9 + 2\,(.035) = \begin{cases} 0.97 \\ 0.83 \end{cases}$$

Thus, it can be stated with a 95 percent level of confidence that we can expect not less than 83 percent nor more than 97 percent of the population to respond in the affirmative.

In reality, we would expect the range between confidence limits to be even less than the 14 percent calculated here because we are dealing with stratified sample. Stratified samples provide higher accuracy with smaller samples than do random samples. The above formula for calculating the confidence limits does not consider the sample to be stratified. It can be concluded that the sample results are both valid and precise.

APPENDIX B

STATISTICAL ANALYSIS OF DIRECTORY USAGE REVIEW RESPONSES

1. Standard error for individual answers.--All of the eight questions on the Directory Usage Review form pertain to organization, operation or adequacy of the Directory except question no. 2. Question no. 2 is "Did you find this Pilot Program Directory useful despite its limited coverage?" This is the only question of the eight that deals with the adequacy of the Directory prepared solely for the Pilot Program (and intended only as a realistic representation). It is impressive to note that two-thirds of the users found the Directory either definitely or marginally useful to them. Only 33 percent stated that it was not useful. These are remarkable figures, considering that the Directory contained only about 20 percent of the available microcircuit characteristics data.

In order to examine a homogeneous group, let us sum up the number of "yes" responses for all questions except no. 2. This amounts to 477 "yes" responses of the grand total of 532 responses. The ratio here establishes the fact that 90 percent of the respondents answered in the affirmative.

To pursue this analysis one step further, let us examine each of the eight questions in terms of the "yes" responses. Using the formula introduced in Appendix A for calculation of standard error, we can plug in the incidence of "yes" responses for each question and determine the individual standard errors. This has been done in Table IV, "Calculation of Standard Error for Usage Review Answers."

The standard error calculated is indicated in the right most column of Table IV. The "standard error" for the first four questions is less than six percent and the standard error for the last four questions is less than three percent. The high reliability level attainable in question no. 2 with only a 31.5 percent incidence clearly demonstrates that precision is obtained primarily from large samples and are only slightly affected by changes in incidence.

2. Analysis of response differences among test Centers.--It is necessary to determine if there are any statistical differences among the responses from the test Centers. If there are, it would be necessary to conduct a further analysis to determine why these differences exist.

The three possible answers to each of the eight questions were organized by test Center. As a first step in the analysis, the total number of responses and the corresponding percentages were arranged in the matrix shown as Table V. It was decided that the most accurate way to conduct the analysis would be to concentrate only on the percentage figures in Table V, specifically

TABLE IV
CALCULATION OF STANDARD
ERROR FOR USAGE REVIEW ANSWERS

(p') $\qquad S_{p'} = \sqrt{\frac{p'(1-p')}{N}}$ $\qquad N = 76$

Question No.	% Yes Response	Calculation of Standard Error	Standard Error
1	89.5	$S_{p'} = \sqrt{\frac{.895\ (1 - .895)}{76}} =$	.035
2	31.5	$S_{p'} = \sqrt{\frac{.315\ (1 - .315)}{76}} =$	.053
3	89.5	$S_{p'} = \sqrt{\frac{.895\ (1 - .895)}{76}} =$	.035
4	70	$S_{p'} = \sqrt{\frac{.7\ (1 - .7)}{76}} =$	.0525
5	92	$S_{p'} = \sqrt{\frac{.92\ (1 - .92)}{76}} =$	.031
6	93.5	$S_{p'} = \sqrt{\frac{.935\ (1 - .935)}{76}} =$	.028
7	96	$S_{p'} = \sqrt{\frac{.96\ (1 - .96)}{76}} =$	.022
8	97.5	$S_{p'} = \sqrt{\frac{.975\ (1 - .975)}{76}} =$	.018

TABLE V
DISTRIBUTION OF DIRECTORY USAGE REVIEW ANSWERS BY TEST CENTER

Centers \ Questions		Directory Usage Review Question Number																							
		1			2			3			4			5			6			7			8		
		Y	N	M	Y	N	M	Y	N	M	Y	N	M	Y	N	M	Y	N	M	Y	N	M	Y	N	M
GSFC	#	10	1	1	3	3	6	11	0	1	9	0	3	12	0	0	12	0	0	12	0	0	11	0	1
	%	84	8	8	24	24	52	92	0	8	76	0	24	100	0	0	100	0	0	100	0	0	92	0	8
MSFC	#	11	1	2	7	2	5	12	0	2	9	0	5	14	0	0	12	0	2	14	0	0	14	0	0
	%	79	7	14	51	14	35	86	0	14	65	0	35	100	0	0	86	0	14	100	0	0	100	0	0
Ames	#	11	0	0	6	4	1	10	0	1	10	0	1	10	1	0	11	0	0	11	0	0	11	0	0
	%	100	0	0	55	36	9	91	0	9	91	0	9	91	9	0	100	0	0	100	0	0	100	0	0
JPL	#	20	0	0	3	8	9	19	0	1	15	2	3	18	0	2	20	0	0	20	0	0	20	0	0
	%	100	0	0	15	40	45	95	0	5	75	10	15	90	0	10	100	0	0	100	0	0	100	0	0
RADC	#	8	1	0	1	5	3	6	0	3	5	1	3	6	1	2	7	1	1	7	0	2	9	0	0
	%	89	11	0	11	56	33	67	0	33	56	11	33	67	11	22	78	11	11	78	0	22	100	0	0
ERC	#	8	1	1	8	2	0	10	0	0	7	1	2	10	0	0	9	0	1	9	0	1	9	0	1
	%	80	10	10	80	20	0	100	0	0	70	10	20	100	0	0	90	0	10	90	0	10	90	0	10

NOTE: Y = Yes; N = No; M = Marginal

to examine the percentage range differences for each question. For example, the "yes" answers for question no. 1 range between 79 percent and 100 percent, for a difference of 21 percent.

Prior to such an analysis, we could not assert that there is a statistical difference of opinion among the NASA Centers until we have established a "threshold" value, indicating the point at which a difference becomes significant. Establishment of this point is somewhat hypothetical. It may be argued that a difference of 50 percent or more is necessary before positive significance to the difference may be established. Although not a proven statistical reality, it is generally true that at least 20 percent of those expressing an opinion in any poll will disagree with the majority.

It was decided to select a value of 30 percent; therefore, all range differences below this value will be construed as showing no statistical difference of opinion among the test Center personnel. The analysis is shown in Table VI and the following discussion pertains to the range differences.

There appear to be significant differences in responses among test Center personnel for questions no. 2, 3, 4, and 5. For question no. 2 there is a 71 percent range difference among affirmative answers. This wide range was due to the fact that 11 percent of the respondents at RADC found the Directory not useful, whereas 80 percent at ERC found the Directory in its pilot version to be useful.

It is purposeless and unnecessary to try to draw any conclusions as to why some of the personnel at one test Center found the pilot Directory more useful than others. The significant point is that 67 percent of the users who submitted Directory Usage Review forms found the pilot Directory immediately or marginally useful. This is a far higher figure than initially anticipated.

There also seems to be a difference of opinion on questions no. 3, 4 and 5 which have a 33 to 35 percent range difference. These questions deal with the categorical breakdown of the digital and linear circuits as well as the characteristics summary headings. It is noteworthy that excluding RADC the range differences are below the 30 percent threshold (14, 26 and 10 percent respectively). The implication is that the RADC personnel were more critical of the microcircuit breakdown and headings than were the NASA personnel.

It is also noteworthy that for questions no. 3, 4 and 5 the RADC respondents who did not answer in the affirmative tended to answer "marginal" rather than express dissatisfaction. In short, they did not disagree with the digital and linear breakdowns, but felt there was room for improvement.

TABLE VI
ANALYSIS OF THE SIGNIFICANCE OF PERCENTAGE RANGE DIFFERENCES AMONG NASA AND RADC PERSONNEL

Question	Yes		No		Marginal	
	Range	Sig.	Range	Sig.	Range	Sig.
1	21	No	11	No	14	No
2	71	Yes	36	Yes	52	Yes
3	33	Yes	0	No	33	Yes
4	35	Yes	11	No	26	Yes
5	33	Yes	11	No	22	No
6	22	No	11	No	14	No
7	22	No	0	No	22	No
8	10	No	0	No	10	No

Criteria: Range difference significant if over 30 percent.

There is no statistical difference of opinion on the remaining four questions. Excluding question no. 2, then, there is no clear statistical difference in the responses from the Centers. The inference is that there is general agreement among all test Centers that the design, utility, and effectiveness of the Directory are sufficient to satisfy the user's need for a desk-top book-form microcircuit Directory.

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APPENDIX C
SALIENT COMMENTS BY PERSONNEL INTERVIEWED

This Appendix consists of verbatim transcriptions of interviews with 85 Pilot Program participants. Every effort has been made to accurately transcribe the user reactions: they have been edited only to facilitate reading, to make them self-contained and to eliminate (as much as possible) specific references to centers and systems. The complete set of pertinent comments are recorded here in the sequence of interviewing; the most important excerpts are summarized in Section VI by major subject categories.

Interviewee No. 1:

It is very expensive and duplicative to have everyone collect catalog data.

Because current interest is moving out of the transistor area, the system we use is not carrying its own weight. Furthermore, there is a 24-hour turn-around time in using it.

The Malfunction Reports coming from various subcontractors could easily be an input to the Data Bank.

The bibliography section of the Directory should include dates of issue.

I am very much in favor of the Data Bank and feel that it will be successful because of my experiences with other information systems.

Interviewee No. 2:

Results from user histories may not be valid; reliability data can easily be misleading. Users must be educated on its misleading possibilities.

It is going to be difficult to find enough people to do the technical job necessary at the input stage.

Microcircuits produced are so variable and batches are so different that tests conducted in the past are not necessarily indicative of current manufacturing capability.

Having someone at the other end do the search and initial analysis work would be a significant time saver to me.

Interviewee No. 3:

Report type information is most important to us.

We use one established system a lot. As a result of this use, our hard copy file is being cut down.

The microfilm file is the most important element of the Data Bank; it may replace our current system in microelectronics.

With enough technical people to do the input functions, it would be a useful system.

To be successful, the Data Bank must be very fast, must have the volume of data that you indicate it will have, and must be properly indexed.

Long reports should be prejudged and an abstract of these reports included on microfilm so the user would not have to read the entire report on the microfilm reader.

A good index to the microfilm file is extremely important. The microfilm index on microfilm itself is not useful.

The Government needs a standardization of stress level environmental factors so as to facilitate interrogation of the Data Bank.

We need data even though it may be somewhat unreliable and/or misleading. Let me decide if it is valid or not.

Interviewee No. 4:

The utility of our present system is questionable primarily because the questions must be too carefully ordered in order to come out with a reasonable volume of data. The Data Bank does not seem to have this objection.

I am more interested in transistors at this time and see no reason why the Data Bank could not include transistors as well as microcircuits.

Interviewee No. 5:

I would have a current need for the Data Bank if it included germanium detectors.

I am interested in finding the reliability of circuits under certain environmental conditions and would use the Data Bank to help collect this information.

I like the idea of the Data Bank and would definitely use it.

Interviewee No. 6:

We cannot rely on manufacturer provided information; if someone in the field has run a test (NASA or DOD) we want to know about it.

The typical questions we would have are: "Is this a good screen? Is this a good device? What does this test do to the device? What is wrong with a specific circuit?"

A communication system is needed badly to get information in fast. There must be some type of organized system or network for reporting this information.

We would also like a reference service indicating who is working on what studies; for example, which laboratories are doing specific studies on failures and failure modes.

The Data Bank would be both a time saver and a money saver.

The kind of bond, wire leads, metalization used on chip and package-type constitute the minimum data needed to obtain background information to determine which circuit is best for a particular application.

The computer could provide an Information Analysis System because there is a lot of complicated computation resulting from the many variables existing. The computer could recognize various types of failure modes for obtaining reliability statistics. It could determine when the process of manufacturing has changed. The computer could be a very useful aid.

The system we have is not used too much because the data is old.

I cannot keep up with the volume of data that exists -- not even by telephone. Would like to see a central purchasing and receiving section who would reject or pass incoming circuits. The incoming inspection at this center is very inadequate.

Interviewees No. 7-12:

(Six persons from a branch, including the branch chief, were interviewed simultaneously.)

The group unanimously agreed that the Data Bank would be a definite help in identifying additional microcircuits meeting their specific requirements that they conceivably overlook using their current method of selection.

The group all expressed an interest in knowing who is using certain microcircuits and in securing user reports indicating satisfactory or unsatisfactory experiences with specific microcircuits.

It was pointed out that existing within the branch was a great deal of information which could be valuable input to the Data Bank.

All agreed that the Data Bank would be a very useful tool and they would definitely use the system.

Interviewee No. 13:

I have used the pilot version of the Directory as it is and found it very useful in two instances.

The second source index is a good idea.

I frequently wish to know what other circuits are equivalent to a specific circuit and could use the Data Bank to give me this information.

Interviewees No. 14-15:

We frequently refer to technical data sheets and would use the Data Bank to provide us with this information.

We like the system as it is designed.

Inverviewees No. 16-17:

(Same comments as No. 14-15 above.)

Interviewees No. 18-19:

The biggest problem the Data Bank will encounter will be the collection of the data necessary to assure success of the system. Much of this information is difficult to obtain.

The system is well conceived and should be used extensively if it contains the information indicated.

Interviewee No. 20:

We want the Data Bank; indeed, we need it rather badly.

The mechanics of this system are good.

We need and want reliability data basically.

To do our job properly, we need data on microcircuits that have been compiled by other Centers. We cannot, alone, do all of the screening necessary.

We need the cooperation of other Centers in the purchase of high reliability microcircuits. Last year, this Center purchased 20,000 microcircuits. This purchase is not large enough for us to get the kind of data we wish to have.

There are not many people at this Center working on reliability; we have a small group. We could greatly benefit by the input from the reliability activities being conducted at other Centers. The use of computers and data interrogation is not new here; our people are used to such computer systems.

A typical question would be, "Which is more reliable -- circuit ABC in TO-5 can or flat pack?"

Every day I get three pounds of data on failures. I cannot possibly digest all of this. Others get this volume of information also. We need a computer system in order to put this information away and a system of being able to get it out when we need it.

Our basic problem is how to choose screens to get the kind of reliability we desire.

Interviewee No. 21:

The computer query capability is most beneficial for circuit designers and procurement people.

I need reliability data most of all.

There is a definite need for a system such as this.

I would defintely use the system, particularly the reliability data.

A typical question would be to find the series of tests a particular circuit has undergone to give an indication of its reliability.

Interviewee No. 22:

People are basically reluctant to give up information; therefore, personal contacts are the only way to get the information.

There is a great demand for test reports, qualification data, and reliability information on microcircuits.

One way to procure data is to require a copy of all test reports to be sent in when a contract is let. A similar directive should be issued covering in-house data.

Controversies can be eliminated by sending a copy of bad test reports to the manufacturers and waiting two weeks for a rebuttal.

A contractor representative went around the laboratory at this Center and personally extracted 100 reports for an operating system. A team approach to collect data would work well.

There is a definite need for a system such as the Data Bank.

To decrease the time between performance of a study and publication of the results, the Data Bank could refer queries to locations where the study is being conducted in advance of publication.

Our current system has a general information category. The Data Bank should also have a general reliability section for reports not concerned with a specific microcircuit.

Microelectronics is important enough to warrant a separate Microelectronics Data Bank.

Just three percent of the data contained in PRINCE/APIC deals with microelectronics. This area could be greatly expanded through cooperation with the Microelectronics Data Bank. PRINCE/APIC cooperates with other data banks in order to enhance its usefulness to its users.

The organization of the Directory is good; it is the right way to go.

There is a considerable duplication between the Directory and the book form index of another system. The Data Bank should emphasize the test and experience data, which is hard to get, and de-emphasize catalog data which is more easily obtainable.

The Data Bank should expand in the area of inventory listings; for example, which NASA Center has bought what microcircuits, including custodian, quantity, and location. This information is vital for mutual exchange of the items and for experience. In addition, item traceability is necessary for reliability purposes in this rapidly advancing technology.

Caution must be used in weeding out reports of doubtful contents. Questionable reports should be passed on with a respective comment by the evaluator.

Reports on tests which determine the qualification or disqualification of certain microcircuit vendors should be available, by all means. The signature and organization of the person making the evaluation and decision must also be included.

Future reports on the Microelectronics Data Bank should outline the interaction of this data system with other data centers. Duplication of efforts should be minimized right from the beginning.

Interviewee No. 23:

My primary need is for reliability data.

The system seems well designed and I would definitely use it if it had reliability data.

Interviewee No. 24:

You would not want all engineers to use the system. Some would use it extensively for decision-making tasks, such as tradeoffs. These people are the "parts specialists" as are other people who recommend circuits to use. For these people there is an additional requirement for further reduction of the data available on the potential circuits for their application.

It would be a good idea to have a group of experts normalize the input data so as to make it most useful. Since the information currently is not normalized, going into too much detail in the Directory would not be gaining much.

Reliability data, if kept up to date, would be very useful.

A "black list" of unreliable circuits as well as a factor to indicate high reliability circuits would be good.

Qualification data is extremely important to me.

ERC ought to perform tradeoff analyses of circuits as a job function.

Interviewee No. 25:

The Data Bank seems to be set up especially for designers.

We do a lot of testing here but budgetary restrictions make it impossible to test everything. We could capitalize on test results from other Centers.

I currently use one existing system to determine if there are any reliability reports on circuits that engineers want me to test. I have found this system very useful in the past.

Interviewees No. 26-27:

Cooperation with other NASA Centers is absolutely essential if the Data Bank is to be a success.

It is imperative that every effort be made to assure that the information put into the Data Bank is valid.

The Data Bank Directory should encompass a circuit classification system similar to the system described in the "Microcircuit Line Certification," the Microelectronics Subcommittee Documents dated June 1967, Figure 2.

The system is well designed and, if the data can be procured, it should be a popular system.

Interviewee No. 28:

The biggest problem will be motivating engineers to put data into the bank; many engineers are even reluctant to write up their own work.

There is not a great need for catalog data since the manufacturers do a good job of letting us know when new circuits come on the market.

There is an important need to know about research going on elsewhere in NASA. There appears to be a lot of duplication of effort not only throughout NASA but within this Center as well. In several NASA Centers persons are not aware of the research going on "down the hall."

I find data in the system we use to be very obsolete.

Interviewee No. 29:

The system is a good idea even if it is just a good source of manufacturer's data sheets, because they are sometimes hard to get. In addition, it is time consuming to organize these sheets and keep them up to date.

As a designer, I would use the system one month out of the year while looking for circuits of potential usefulness to my project. However, it would be valuable to me at that time.

We rely heavily on the quality and reliability people to write a good specification and check the parameters.

I am most interested in propagation delay and rise/fall time. But it is also important to know under what conditions was it measured, and what is the loading capacitance. The data sheets do not always give this information.

As a designer, I would use the computer query capability.

Interviewee No. 30:

When a new circuit comes out I always want to know how many others have used it, tested it, and what were the problems associated with it.

Reliability data is very difficult to get on new devices. My main problem is finding out what experiences others have had with a particular circuit.

There is not enough information or knowledge disseminated about circuits available from the smaller manufacturers. The Data Bank would greatly help out in this area.

The main advantage of the microfilm file is that someone else keeps it up to date for you and you maintain file integrity because no one can run off with your file.

The manufacturer's data sheets have many gaps of information. We need the manufacturer's in-depth data to see the total graph of the curves, not just particular points or averages.

Interviewee No. 31:

There is a definite need for a system like the Data Bank.

If you can collect timely qualification and reliability reports on new microcircuits, it would amount to somewhat of a breakthrough.

Interviewee No. 32:

The system looks very good. The big problem will be in obtaining the data.

Interviewee No. 33:

The primary need is for information on new circuits. Most of the other information systems contain old data of little interest.

Interviewees No. 34-38:

(Five personnel from the PRINCE/APIC system were interviewed simultaneously.)

An independent look at the quality in reliability of microcircuits -- not the vendor approach -- is what is important to the success of the Data Bank.

We have to agree heartily with all aspects of the system design. We don't, however, use microfilm because we do not disseminate our files to multiple locations.

The decentralized file concept has been proven. However, the economics of the system should be studied further; that is, the cost of an inquiry on a centralized versus decentralized basis should be considered.

Cooperation between the systems should take place from the start in order to minimize duplication and maximize the usefulness of the information interchange.

Currently, the amount of microcircuit data in PRINCE/APIC is small. In the area of microelectronics, PRINCE/APIC would certainly benefit from a cooperative agreement with the Microelectronics Data Bank, and PRINCE/APIC would be able to provide the Data Bank with information it obtains from DOD sources not readily obtainable by the Data Bank.

There is a great deal of difference in the detail design, overall approach, and content of the Data Bank versus PRINCE/APIC.

Interviewee No. 39:

There is a desperate need for a system such as this, and I am sold on the idea of the Data Bank.

The Data Bank as currently designed could and should include discrete parts as well as microcircuits.

We will have a central group at this Center responsible for getting data for input to the Data Bank.

There is a built-in reluctance on the part of manufacturers to release test data because they don't want the Government to know that they did not do all the testing they should have.

Very little electronic design is performed here; we contract most of this work out.

The term "Data Bank" should probably not be used in the title because of its undesirable connotations. However, the word reliability should not be used either because of the different viewpoints of its meaning.

The Data Bank should be set up in stages. Monolithic should be furnished first with hybrids next, followed by LSI. However, the way things are going it may be necessary to go directly from monolithic to LSI in one jump.

Interviewee No. 40:

Reliability data is not as important as design information to me.

Detailed specifications and in-depth data will be of great value to me and this entire branch. Application notes are also very valuable.

The parameters used to describe linear integrated circuits in the Directory are not complete; more specifications are needed.

I am particularly enthusiastic over the system.

Interviewee No. 41:

It is important that up-to-date information be provided.

There is a definite need for this system and it will be used.

Information is conveniently available to us here directly from the manufacturers; however, too much dependence is placed on gossip and not enough on factual reports.

There are so many integrated circuit families on the market it is difficult to determine which one to use. Therefore, breaking the Directory down first into family type is most useful. The Directory now sorts family (or logic type) as the second sort. Besides organizing the circuits into ten sections, an additional section should be devoted to listing the circuits by family.

Price information would be very useful.

The FTS line from the West Coast to the East Coast is usually not too good. This, along with the time difference, makes it somewhat harder to fully utilize the computer.

Interviewee No. 42:

Currently I am not using microcircuits; however, the system would be useful to me when I become interested in integrated circuits. I would use the system.

Interviewee No. 43:

I certainly could use the system right now. I am mostly interested in parts qualification data.

Interviewee No. 44:

There is a definite need for this Data Bank.

I would recommend that the Data Bank be expanded to include semiconductors.

Interviewee No. 45:

The services provided by the Data Bank are interesting; it can help designers gain information not available now.

Rapid access to information is very valuable to us. The advantages to us are really great.

Whether it will be used is hard to tell. The delay may be critical to users; too much delay will kill it.

Producing quality circuits is not an exact science, but certain things can be done to ensure good circuits. The thing that really counts is how well the circuits are built. The manufacturing quality is an unobservable thing to NASA. The Data Bank can provide a very useful service if the reliability reports and the certified lines listing will help us understand what is going on inside the manufacturing plants.

Interviewee No. 46:

I am currently interested in discrete parts only and believe most people are likewise.

I have not used the system located at another Center but I would use the Data Bank if it provided useful information.

Interviewee No. 47:

The system has been well thought out and has the right categories of information.

The Data Bank design is so sound that we are setting up a data system on contractors patterned after it.

There is a definite need for this system, particularly in light of the rapid changes in technology. In this type of data bank you can be flexible enough to keep pace with changing requirements. In our case, we deal with so many contractors we would have a definite need for the system.

Getting data into the bank is primarily a contractual matter.

We need a system that stays up with the state-of-the-art on integrated circuits. The average NASA Center cannot keep up because it would take about 120 people to do it.

One contractor keeps a staff on the road at all times to keep abreast of industry and technological advances.

Today, information is obtained basically through personal contacts. It took me eight years to prepare my two "black books" of personal contacts without which I could not obtain the information I need.

A consulting firm is now teaching a course on manufacturing integrated circuits. I have found out that they are currently eight months behind the technology right now.

The Directory should indicate how many reports are in the system for each of the categories included in the microfilm files.

Price ranges, rather than exact prices, could be included in the Directory. This will help in doing cost effectiveness studies. The prices given should be most current off-the-shelf prices. With this information, the Directory would be consulted even more.

Interviewee No. 48:

The basic need is for reliability and qualification data.

The basic problem is getting people to contribute data into the bank.

Lots of information may not find its way into the system unless, like we are doing, a formalized reporting system for submitting failure information is instituted.

It is important that contractors have use of this system because many of the parts are bought and selected by them.

Designers want the characteristics data in better shape and, therefore, would use the Data Bank.

No matter how good the system is, there will be a job of convincing people to use it -- the NIH (not invented here) factor must be overcome.

There is a universal problem of recognizing a part having many names or numbers. A good cross index between manufacturers numbers is needed. This is a growing problem in microcircuits and is a serious problem on discrete parts right now.

Placing the Data Bank on standard distribution lists is a good way of data collection.

Interviewee No. 49:

There is a definite need for such an information system.

There is a big problem of keeping track of parts having numerous numbers. The system should contain and maintain a cross index of such numbers.

Interviewees No. 50-51:

Talking to an analyst at the other end of the telephone is a good idea; I have tried it the other way and it doesn't work. It is hard to justify paying for direct access.

The problem regarding the use of different supply voltages, other than those specified by the manufacturer, and the effect upon other parameters by doing so, is a problem that must be looked into. Some of this is discussed in the manufacturers' data sheets. The Directory should indicate, insofar as possible, that a circuit can operate under different voltages.

This system could be a leader in the area of standardization, particularly in standardization of parameter definitions. It is quite conceivable that the Data Bank could become a very popular information system.

Interviewee No. 52:

There is definitely a need for a system like this; I would use it.

It should be expanded to include discrete parts as well as microcircuits.

Interviewee No. 53:

There is a definite need for a system and the approach of the Data Bank is good.

The success of the system is dependent upon the participation of the members; the greater the participation, the more successful the Data Bank will be.

It is almost inevitable that the Data Bank should be expanded to include other than microelectronics.

The decentralization of people at our Center presents a problem with the microfilm files. There would have to be three or four microfilm files set up here.

The Data Bank should evaluate the worth of the data rather than determining whether it is applicable to a particular project. Each project is different and the information obtained must be uniquely evaluated against each project. The Data Bank, therefore, should provide the vehicle for determining if the data is good or not.

The Data Bank will need parts specialists or component specialists and reliability engineers to put the data into proper perspective.

The Data Bank should not be hardware or organizationally oriented. It should be modular in construction.

I prefer an interface with an analyst; the computer is stupid.

The main problem will be obtaining timely information; the second problem is determining if the information is any good.

The Data Bank must have parts specialists to perform analyses and draw conclusions. This brings up the question, "Can the Data Bank get away with advertising negative information about products?" The manufacturer's standard answer is that "this is not representative of our product." One solution to this problem could be limited distribution of the information.

By and large the Data Bank received a very good reception here.

Interviewee No. 54:

Every designer has his own set of books as a status symbol. As a result, there may be some built-in reluctance toward acceptance of the Data Bank.

Having one phone number to pick up to determine usage experience of others is a very valuable asset.

It is extremely important that we find out what the failure problems are for specific microcircuits.

It is important to get people at every level to use the Data Bank.

Since this Center is principally doing research work, it will be a major data contributor to the bank.

We would like to use other's input too since it is easy to get burned with state-of-the-art data.

One-third of my time is spent determining whether the test data is good or bad. Fifty percent of the tests are bad. Fast tests with high accuracy are virtually impossible.

A computer could definitely determine if the test data is good since we do that now manually. Standards are used to select the good data.

We have a great amount of data collected but retrieval is rather difficult.

In some special cases you might want to have raw test data.

The system should be utilized outside of the NASA community because with more users you will get more input and more support.

<u>Interviewees No. 55-57</u>:

(Three engineers were interviewed simultaneously.)

We frequently do select circuits and try out new circuits and would use the Data Bank to help out in this task.

Proximity of the microfilm is important if it is to be used.

Limited scope of the data in the pilot precludes its usefulness to any major degree.

Frequent update of the system will be necessary.

Interviewee No. 58:

I am generally in favor of the services afforded by the Data Bank and have no particular complaints or criticisms.

The most useful part is reliability information not generally available elsewhere; I would really like to see such data.

Emphasis should be placed on reliability and usage data; this information is needed badly.

Interviewee No. 59:

I like the system and would use it if the information is entered into the system as planned.

The system should be expanded to cover other components besides microcircuits.

Interviewee No. 60:

(Same comments as No. 59.)

Interviewee No. 61:

There is a tremendous need for this system since a great deal of interface time is spent with component engineers in acquiring data.

The organization of the Directory is good and very useful.

We want to know what everyone else has been doing. Thousands of dollars are spent in travelling around obtaining this information on a continuing basis.

Generally we do not rely on catalogs because we do not have the time to keep them up to date.

The second source index would be useful. To me a second source means an identical circuit.

Twenty-four to forty-eight hour feedback is okay since it sometimes takes weeks to get information now.

I am interested in both reliability data and test data as we are responsible for design and selection of components.

The system layout of the Data Bank is a definite match with respect to our operational problems.

A while back I made fifteen telephone calls in a three-day period to obtain data that would have been readily obtainable from the Data Bank in a matter of minutes.

If the data is not timely, the system will not be successful.

If I have to fill out paper work in order to obtain the information, chances are I would not use it. It must be easy to use with little or no paper work involved.

I would not object to calling a local man who would collect all queries and relay them to the computer; this would save me time in making the telephone call myself.

Interviewee No. 62:

I am interested in the bibliography data primarily.

Our contractors would probably use the system more than we would.

The parameters in the characteristics summary are adequate.

The microfilm file would be used if it is not too far away.

We select circuits on the basis of who sent us a catalog.

Interviewee No. 63:

The Data Bank is a good idea, but to maximize usefulness it should utilize a time-sharing technique in order to shape your query through a man-machine interchange. I do not think the lead time is short enough on a telephone query; the time lag is significant. In general, in our area the answer is usually in the form of a matrix which is not amenable to oral communication.

There is a definite need for more information and more reliability information.

The system must be timely, fast, and complete if it is to be a success. I have had to wait from six to eight weeks for receipt of manufacturers data sheets.

Interviewee No. 64:

The computer is the most important link in this system.

The analyst is a vital element as he provides an effective interface.

The computer hardcopy sent to the inquirer should include a configuration of his inquiry or plan of research to assist him in restructuring his query if need be.

The process of filling out summaries needed for one present system is too time consuming and we enter only the information we have to.

In the Data Bank index the number of documents available in each category should be printed rather than the asterisks.

The characteristics summary should not be expanded to include any more data.

The system we currently use falls short because the data is too old to be useful.

Interviewee No. 65:

A system with full capabilities would have great possibilities.

Short response time is very important.

Reliability data is very valuable as would be the flash notifications, provided the information was verified and accurate.

An expanded system providing computer-aided design capabilities would be very useful.

Interviewee No. 66:

I am a very enthusiastic supporter of the Data Bank system concepts.

Our normal design cycle first asks for anything that comes near our requirements; secondly, the circuits that have the best electrical characteristics; and finally, the circuit that has the highest reliability.

The Directory is the most useful element, the microfilm files second and the computer least.

I performed an exercise with the microfilm files and was pleased at the amount of information available. I found it quite useful. I also liked the speed of retrieval.

Personally I am very much in favor of the system and think it is a big step forward.

Interviewee No. 67:

The idea of the system is good and I would use it.

Interviewee No. 68:

I use both reliability and design information.

The characteristics summary has enough parameters for a first pass.

The characteristics summary should include more details about the structural differences between the circuits.

Interviewee No. 69:

The circuits we ultimately select and use usually are not optimum because we do not have the time to devote to a total search of available circuits to meet our needs. The Data Bank would provide a tool to conduct a complete search. There is a definite need for this system; most other systems do not contain timely information.

The overall design approach is a good idea; the system gives the broad scope for overall orientation. The detail is then available for specifics. This is a good approach.

The Directory located on my desk is an excellent idea; could be very influential in decision making.

Interviewee No. 70:

We are primarily interested in new circuits and there is not much information available when we need it.

The Data Bank is a good system although somewhat idealistic.

The team of people who go out to extract data must be technically competent; they should be hired from the manufacturers themselves.

The data collected must be evaluated. The evaluation is very important and must be stressed.

There is a definite need for this Data Bank.

If good quality and current data is included the Data Bank will be used.

Interviewees No. 71-72:

We are very much interested in finding out who else is working on specific logical systems.

There is a definite need for such a system and we would definitely use it.

We like the scanning feature to get the overview as to what is available.

After the overview and determination of a small number of candidate circuits we then need reliability data in order to make the selection.

Interviewee No. 73:

The Data Bank is designed in such a way that it matches exactly the method we would employ in using it.

For detailed selection, reliability data is absolutely essential.

We also need cost data. A cost range would be acceptable.

We are interested in vendor performance: Did they meet the specifications, reliability, performance, delivery dates, etc. ?

We would not use the Data Bank a lot; however, it would be quite useful when we needed it.

The LSI area is becoming extremely important and should be included within the Data Bank as soon as possible.

The Directory probably has enough data from a logical standpoint; however, a circuit designer might want more information.

We would like to know if we could use a different voltage than that specified by the manufacturer, and what would happen if we did.

We would like to be able to receive test parameter distributions and test curves, what you call the in-depth data.

Would prefer on-line access to the computer.

I would also like to see logic minimization programs in the area of computer-aided design.

Interviewee No. 74:

The system is useful; there is a need for it and the concept is great.

Unfortunately, in its present state it is very difficult to evaluate.

The microfilm is great, but updating may cause user disenchantment if a lot of searching is involved.

I would be interested in using both reliability and characteristics data.

Interviewee No. 75:

We, the Reliability Branch, would use the Data Bank.

The reason that most of the people here didn't use the system more is because it did not have enough information in it -- especially applications and failure data.

We had to use a very old hand-crank reader/printer. It gave very inferior microfilm prints, and the manual feature was difficult to use.

We are using an official manual on data submission requirements, and it may allow for automatic submission of data.

Publication of invalid data, no matter how small, will severely damage the reputation of the Data Bank.

One group here builds circuits in order to study improvements in technology. We are interested in the application of devices to systems.

Sufficient effort at the front end of the system, the data collection, will make or break the system.

There would actually be very little duplication of effort between the NASA Microelectronics Data Bank and MIAC (Microelectronics Information Analysis Center) in the Air Force. MIAC is concentrating on Air Force systems; the

Data Bank would be concentrating on NASA systems. The only duplication would result in covering joint NASA/Air Force projects, but this could be controlled in order to avoid duplication of coverage.

We have found that failure mode information is not very valid when generated by our people. Field failure data is valid only if contractor maintained.

Interviewee No. 76:

I am mainly interested in reliability data; it is difficult to find much of this information.

I have a definite need for the second source index.

Organization of the Directory is good as are all of the other procedures in using the Data Bank.

I would like more direct access to circuits used by specific projects.

I interrogated the computer. On the first try my specifications were too tight and received no matches. Then I relaxed the parameters and got several matches that provided some useful information to me.

I would definitely use the system if it had information in it.

For each circuit I am interested in I would like to know the set up for the burn in (in-depth data) as well as field data on results of user experience. The two together would really be something. This kind of service is not available anywhere else.

I did not mind the delay in mailing the computer output from Boston because it takes me just as long to get an output from our own computer.

The microfilm system is okay but I had trouble using the hand-crank reader/printer.

It would be desirable if the Data Bank could provide a hard-copy service for longer reports which you would not want to put on microfilm.

Color pictures are sometimes important in working with microcircuits. The microfilm should have color pictures if the picture shows some information not readily observable in black and white.

Interviewee No. 77:

More than one microfilm reader/printer would be necessary in order to make it more convenient.

If I want hard copy of 50 pages I do not want to sit at the microfilm reader and print it all out. Some method must be employed to provide me with the hard copy.

Our current system is not complete enough; there is not enough detail about what parameters are used.

I have little problem finding information about circuits from the manufacturers' data sheets; however, I need more failure data -- particularly how devices operate in different environments.

Telephoning the computer may be cumbersome because sometimes it takes me over one hour to get a line through.

The propagation delay, fan in/out, power dissipation, and logic type are the most important characteristics to me. Structure is not too important; however, bonding and the type of insulation are important. The manufacturing process is also very important.

The biggest payoff for the Data Bank would be in the area of linear circuits, particularly linear applications data. I get phone calls all the time for amplifiers with specific characteristics. It is very hard to select linear amplifiers because of their variety and the large number of them.

Interviewee No. 78:

The Data Bank must do some type of analysis of the data to make it useful. The system would be a good source for developing and updating models or tradeoff procedures needed to determine reliability of a device.

Raw test data is not useful in itself; some work on reduction of this data should be done.

Timeliness and currency are important.

The trend of reliability with time is nice to know for top-level planning. By this I mean some correlation between reliability of a device and how it is put together. The computer could probably help out here.

We are producing reliability notebooks (the first available in November 1967 and the second available in Spring 1968) which ought to be incorporated in the Data Bank.

Analyses by contractors are biased; a central source for collection and analysis is better and more complete.

The computer could probably help out in preparing reliability models. EIA and one of the contractors are doing work in this area.

Interviewee No. 79:

I performed a computer query and got very quick results. The mechanics of the Data Bank are fine but the data itself was not too useful.

Content of the Directory is fine; cannot offer suggestions for additions.

Of importance to me are the failure modes. This information would indicate the proper types of screens to be employed.

Usage history must be tied to the specifications in order to determine what screens were used, burn in, etc.

What the Data Bank is attempting to do is a lot of work but we must start somewhere. We can't say it is too big a job, so let's not tackle it. Something must be done.

I do use one of the services from a general point of view; however, they go back to the vendor before publishing and this leaves a feeling of bias in the results.

In order to be successful the Data Bank must provide quick response, be up to date, and be very complete.

There is a definite need for this system.

A query response within 24 hours is perfectly adequate.

Interviewee No. 80:

Reliability data would be particularly valuable to us.

I would use the system. The computer query would be used; not often, but valuable when we need it.

Environmental test data is of most use to us.

Mathematical modeling data, e.g., failure rate information, is also quite valuable.

Raw data is not too valuable; there is very infrequent need for it. This data should be summarized.

Interviewee No. 81:

A system like this is needed in this Center. The overall concept is a good idea.

I have a need for this system. I currently keep a set of about 20 manufacturers and I update them when I receive updating material.

I did try out the microfilm file and found no problem in using it.

It is important that data on a new circuit get into the system as soon as possible after the circuit comes out; the Data Bank must be current.

The Data Bank must make an effort to procure data not on the data sheets; this implies determining what data is missing from the data sheets.

The Data Bank is far better than another system we use, because it gives information in greater depth and more detail.

Interviewee No. 82:

There is a definite need for this system, specifically for the digital designer.

I anticipate you will have no problem of being as thorough as you say you will be in collecting usage history data.

Currently, most "system" designers do not get down to the details of component selection; however, with the advent of LSI, this might change significantly.

We do select circuits to be used for special purpose test equipment or breadboards to check out other systems. Therefore, we would have a use for circuits not on a preferred parts list.

It is important to incorporate as much reliability data as possible in the system.

Interviewee No. 83:

Would definitely use the system in performing my work in circuit design (primarily analog circuits).

Most circuit designers know what circuits are available, but they rely primarily on those circuits they are already familiar with and frequently overlook other circuits that are better. The Data Bank would make it possible to conduct a thorough search.

The idea of a computer query is good. It would save the designer several days of searching if the computer could give him circuits which meet stated criteria.

We generate a lot of material that could be an input to the Data Bank.

Interviewee No. 84:

The idea of the Data Bank is great -- you are doing part of the designer's job for him and probably better because he does not have the time to do a complete search.

The system is necessary to help the design engineer select preferred parts.

The desk top Directory is a valuable tool to the design engineer -- he would be foolish not to use it as a handbook to help him do his job.

Use of the microfilm files should not present any problems.

Interviewee No. 85:

The Data Bank idea is very useful and people will use the system if you can build up their confidence.

The digital and linear dichotomy is incorrect. The usual phraseology is linear and nonlinear or analog and digital. The latter is probably the best terminology.

In designing the search criteria it would be better to ask the inquirer to distinguish "must" characteristics and "desirable" characteristics. This approach will provide him with more information and provide a better service.

The Data Bank must be accurate and comprehensive in order to be successful. Users' confidence must be obtained before they will use it.

Some scheme for inclusion of cost data should be made. With cost information you could have a trade-off with "must" and "desirable" characteristics in selecting circuits. A price range would be a useful ball park number.

In the long run, I would prefer direct computer query. Routines would have to be written to translate a single request to a complex computer query.

The personal interviews described above were conducted by:

C. W. Watt - NASA/ERC - CQS

P. MacDonald - NASA/ERC

M. C. Gechman - Information Dynamics Corporation

APPENDIX D

COMPUTER QUERY - LOG BOOK

	Date	Location	Name of Requester	Request	Turn-around Time
1.	14 July 67	GSFC	Morton Hornstein	Circuit characteristics search plus test report information	15 min
2.	19 July 67	MSFC	Dr. A. Holladay	Circuit characteristics search	10 min
3.	20 July 67	MSFC	Relayed through Dr. A. Holladay	Circuit characteristics search	15 min
4.	21 July 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	15 min
5.	21 July 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	15 min
6.	21 July 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	15 min
7.	24 July 67	GSFC	Steve Morrison	Failure report information	10 min
8.	24 July 67	Ames	Relayed through Ray Spence	Circuit characteristics search	1 day
9.	27 July 67	MSFC	Relayed through Dr. A. Holladay	Circuit characteristics search	20 min
10.	28 July 67	GSFC	J. Zellner	Circuit characteristics search	15 min
11.	28 July 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	30 min
12.	28 July 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	30 min
13.	31 July 67	MSFC	Relayed through Dr. A. Holladay	Circuit characteristics search	15 min

	Date	Location	Name of Requester	Request	Turn-around Time
14.	8 Aug 67	RADC	P. Manno	Circuit characteristics search	20 min
15.	17 Aug 67	RADC	P. Manno	Circuit characteristics search	60 min
16.	18 Aug 67	GSFC	Roland Van Allen	Circuit characteristics search	15 min
17.	18 Aug 67	GSFC	Roland Van Allen	Circuit characteristics search	15 min
18.	22 Aug 67	GSFC	D. Seekins	Circuit characteristics search	15 min
19.	24 Aug 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	20 min
20.	24 Aug 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	20 min
21.	24 Aug 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	20 min
22.	24 Aug 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	20 min
23.	24 Aug 67	GSFC	Charles Moyer	Second source information	10 min
24.	25 Aug 67	GSFC	Morton Hornstein	Circuit characteristics search	15 min
25.	30 Aug 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	20 min
26.	30 Aug 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	20 min
27.	30 Aug 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	20 min

	Date	Location	Name of Requester	Request	Turn-around Time
28.	31 Aug 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	20 min
29.	31 Aug 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	20 min
30.	31 Aug 67	JPL	Relayed through Paul Antolch	Circuit characteristics search	20 min
	ORIENTATION DEMONSTRATIONS:				
31.	21 June	IDC	R. D. Morrison	Circuit characteristics search	10 min
32.	10 July	GSFC	M. Gechman	Circuit characteristics search	15 min
33.	11 July	GSFC	P. MacDonald	Circuit characteristics search	15 min
34.	13 July	MSFC	P. MacDonald	Circuit characteristics search	15 min
35.	14 July	MSFC	P. MacDonald	Circuit characteristics search	15 min
36.	19 July	JPL	R. D. Morrison	Circuit characteristics search	15 min
37.	20 July	JPL	R. D. Morrison	Circuit characteristics search	15 min
38.	21 July	ERC	R. Trent	Circuit characteristics search	30 min